ENGINEERING AND MINING JOURNAL

A McGRAW-HILL PUBLICATION

JULY 1951

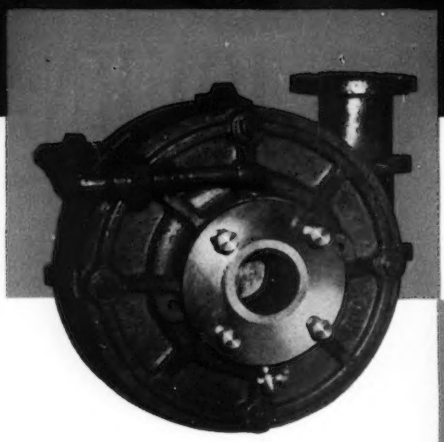
PRICE ONE DOLLAR

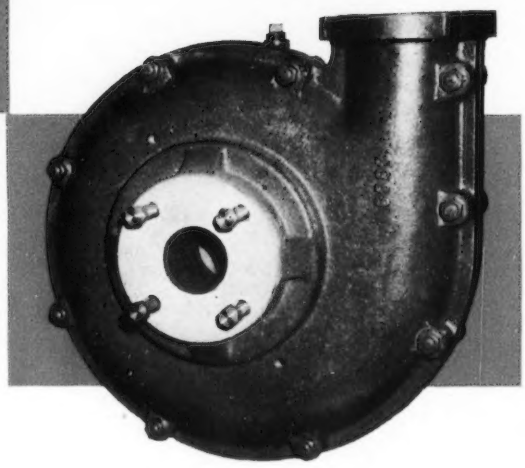
FOUNDED 1866

Production For Defense

★ EXPLORATION ★ MINING ★ MILLING ★ SMELTING

Change-overs are easy—with HYDROSEALS





Suppose you have an A-Frame Hydroseal like the one above. For a year or two now, it's been operating in the capacity range of from 25 to 150 G.P.M., with perhaps a million-ton-plus record of abrasives pumping behind it. Now you need a bigger pump because of expanded output in the war effort. But you don't have to buy a whole new pump for the job. . . . All you have to do is get a larger shell and liner, and you have an AB-Frame Hydroseal with a capacity range of from 75 to 300 G.P.M. After only a few minutes' work, you've doubled your pumping capacity! The pump impellers are interchangeable in this range, which makes the conversion all the easier and more economical. Furthermore, you can quickly adapt Hydroseals for slurry, sand, and dredge applications, as required.

The B-Frame (250 to 700 G.P.M.) and C-Frame (600 to 1800 G.P.M.) can also be doubled in capacity, but in these ranges the impellers must also be changed to effect the conversion.

Such flexibility in size and application is inherent in the design of Hydroseal Pumps and Pumping Systems, and it's just one of the qualities that add up to perfection in abrasives handling.

For complete data—write for Catalog 451.

THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. B, 259 E. Lancaster Ave., Wynnewood, Pa.
Representatives in Most Principal Cities

HYDROSEAL SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED

HYDROSEAL, PACKLESS AND MAXIMIX DESIGNS ARE COVERED BY PATENTS AND APPLICATIONS IN THE MAJOR MINING CENTERS OF THE WORLD

Here's Why You Can Drill Out a Round *33% FASTER* with the new DJB-2 boom jumbo

● Field reports *prove* that this air-operated boom jumbo will drill out a round in one-third less time than with conventional column and arm methods. That's because *set-up time* is converted into *drilling time*. There's no need to wrestle with heavy arms and machines every time you start a new hole.

An I-R air motor raises or lowers the drill to any desired position at the touch of a finger. It operates the boom through a rugged, self-locking screw drive which prevents creeping or settling, and holds the boom firmly in place even after the air is shut off. This simple, dependable mechanism will withstand abuse and is not easily affected by acid mine water or muck.

The DJM-2 Boom Jumbo is available as a compact, car-mounted unit—complete with built-in air and water piping, self-contained lubricator, and universal, 16-ton ceiling jacks for fast, easy anchoring in any underground location. If desired, the booms can be furnished separately, for installation on single or multiple unit rigs. Ask for full information on the I-R drilling combination, consisting of the Boom Jumbo, DB-35 drifters, aluminum shells and carset Jackbits.

ROCK DRILLS • COMPRESSORS • AIR TOOLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL & GAS ENGINES

RESEARCH KEEPS **B.F.Goodrich** FIRST IN RUBBER

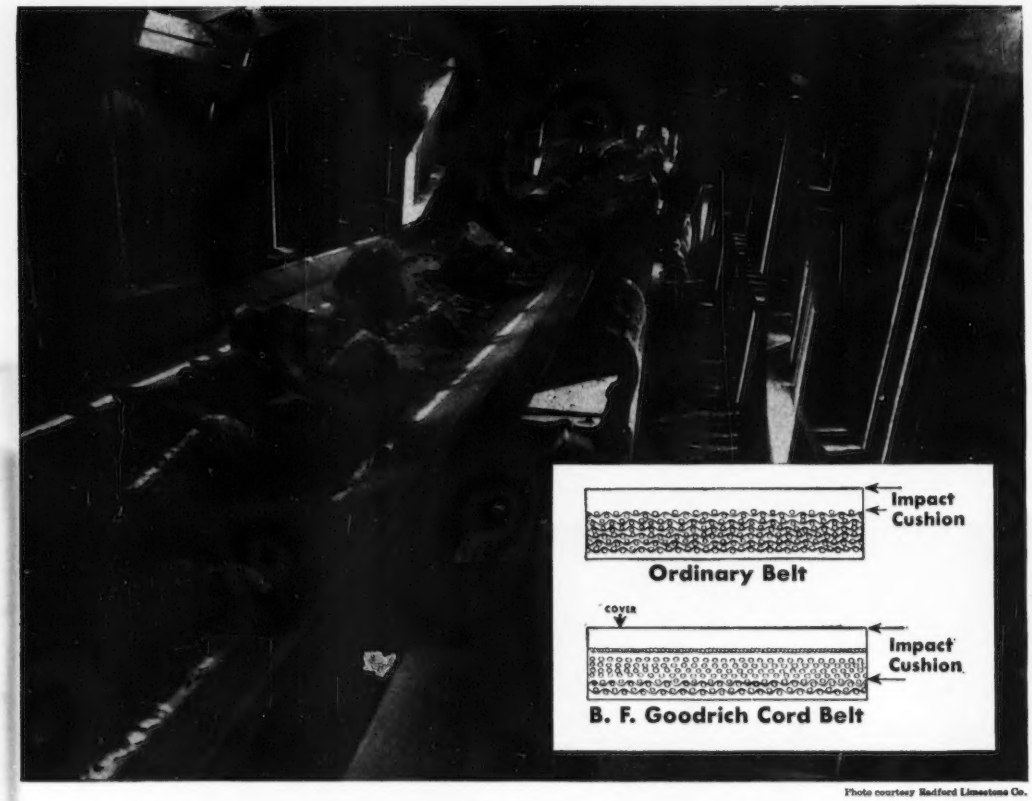


Photo courtesy Radford Limestone Co.

B. F. Goodrich cord belt now in its 12th year

Gives 2 to 6 times greater impact resistance

THIS belt carries crushed limestone from a crusher to scalping screens. It was one of the first B. F. Goodrich cord belts ever put into service. Installed in 1939, it replaced an ordinary belt that wore out fast. But the BFG cord belt has carried over 3 million tons of stone, and the limestone company says it still looks good for a lot more service. Here are the reasons for this extra long life:

Cord belt stands more impact—Each lengthwise cord in a B. F. Goodrich cord belt is completely surrounded by rubber—no cross threads tie them together. Cords are free to "give" when impact occurs. Rubber distorts temporarily, distributing and absorbing a shock that would damage stiff, unyielding plies. As an extra protection, B. F. Goodrich has added a patented *Transcord Breaker*—an extra layer of parallel cords in rubber, placed across belt width. Acts as a shock absorber, stretches to prevent gouges and cuts from splitting belt cover.

Cord belt troughs better—There being no crossweave in the cord plies, cords are free to flex. Belt conforms to idlers, pulleys. Spillage is reduced, troughing is natural and belt keeps centered on idlers, sustains less damage, requires less maintenance. Longer centers, higher lifts can be used.

The first B. F. Goodrich cord belt ever made is still on the job after 14 years and 16 million tons of rough-riding coal. If rock, coal, sand, gravel, ore or any other material rough-rides your conveyor, you can save money by calling in your local BFG distributor. *The B. F. Goodrich Company, Industrial and General Products Division, Akron, Ohio.*

Conveyor Belts BY
B.F.Goodrich
RUBBER FOR INDUSTRY

ENGINEERING AND MINING JOURNAL

VOLUME 152 — 85th YEAR OF PUBLICATION — NUMBER 7

JULY, 1951

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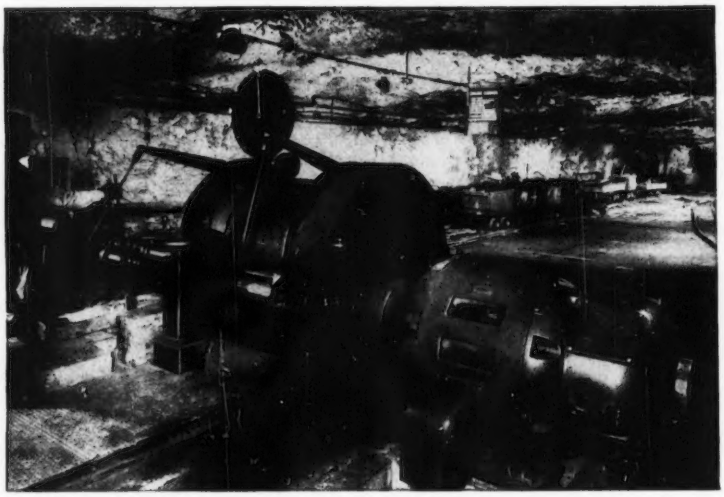
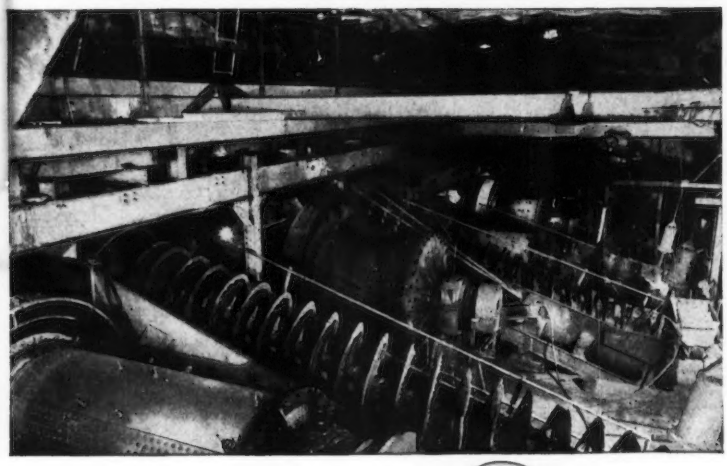
Underground lead-zinc mill hits 1200 tons per day!



1 Hauling cars of lead-zinc ore up 15° slope to the underground mill is this 72" drum hoist, driven by G-E 300-hp 440-volt motor and control. Only one of its kind, the Gilman lead and zinc mill was built entirely underground because in the mountainous terrain surrounding it there is not enough level country. Several hundred feet down, in rooms cut out of hard rock, crude ores from the adjacent mine are concentrated for smelting at distant plants.

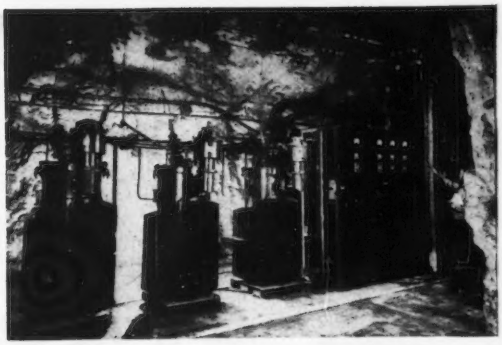


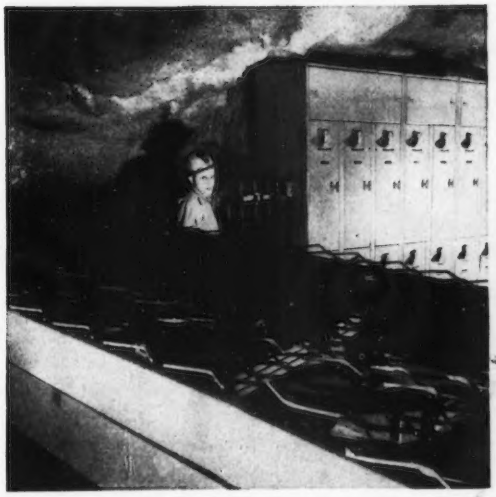
2 In the underground grinding room, two 100-hp and two 75-hp 440-volt G-E motors and control drive grinding mills. Classifier drives consist of four 10-hp G-E motors and control. Naturally heated to 83F, water for grinding process is pumped from mine to mill by G-E induction motors.

GENERAL ELECTRIC

660-23

Co-ordinated G-E drives and distribution equipment help maintain continuity of production at New Jersey Zinc's unique Gilman, Colo. concentrating plant

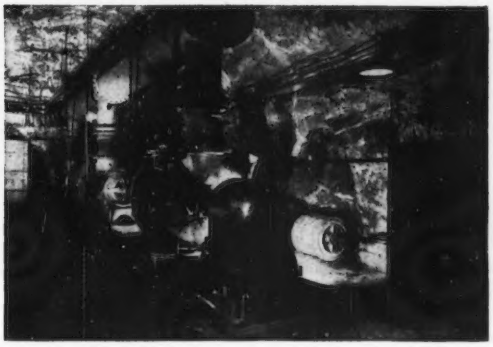




5 **Power for the mine** comes down from the surface at 13,800 volts through 4500 feet of G-E armored cable. At this substation—comprising a G-E switchboard and three 150-kva Pyranol† transformers with gas absorbers—it is stepped down to 440 volts for utilization throughout the mine's two lowest levels.

3 **Grouped motor control** is provided at several points throughout the mill by compact G-E Cabinetrol* units. Space-saving Cabinetrol "packages" include all controls and instruments needed for various milling processes. This neat assembly, together with its associated push-button stations, is located in the mill's flotation cell room.

6 **To protect equipment** against damage from excessive overcurrents caused by heavy overloads or short circuits, the mill uses four G-E 3-pole air circuit breakers rated 600 amperes, 600 volts. G-E air-circuit breakers, selected for adequate interrupting capacity, help safeguard against loss of production in all milling operations.



4 **After grinding the ore,** lead minerals are separated from zinc minerals and waste and then zinc minerals are separated from waste tailings in flotation cells. Air for flotation cells is supplied by these blowers, driven by three 125-hp 440-volt G-E a-c motors, with G-E control at right.

*Reg. trade mark of General Electric Co. for enclosed control panel equipment.

CO-ORDINATED EQUIPMENT *for the Mining Industry*

At every stage in ore processing—mining, concentrating, smelting, or refining—a G-E mining industry specialist can help you solve your electrical problems efficiently, economically. He's a good man to know. Call him soon! *General Electric Company, Schenectady 5, N. Y.*

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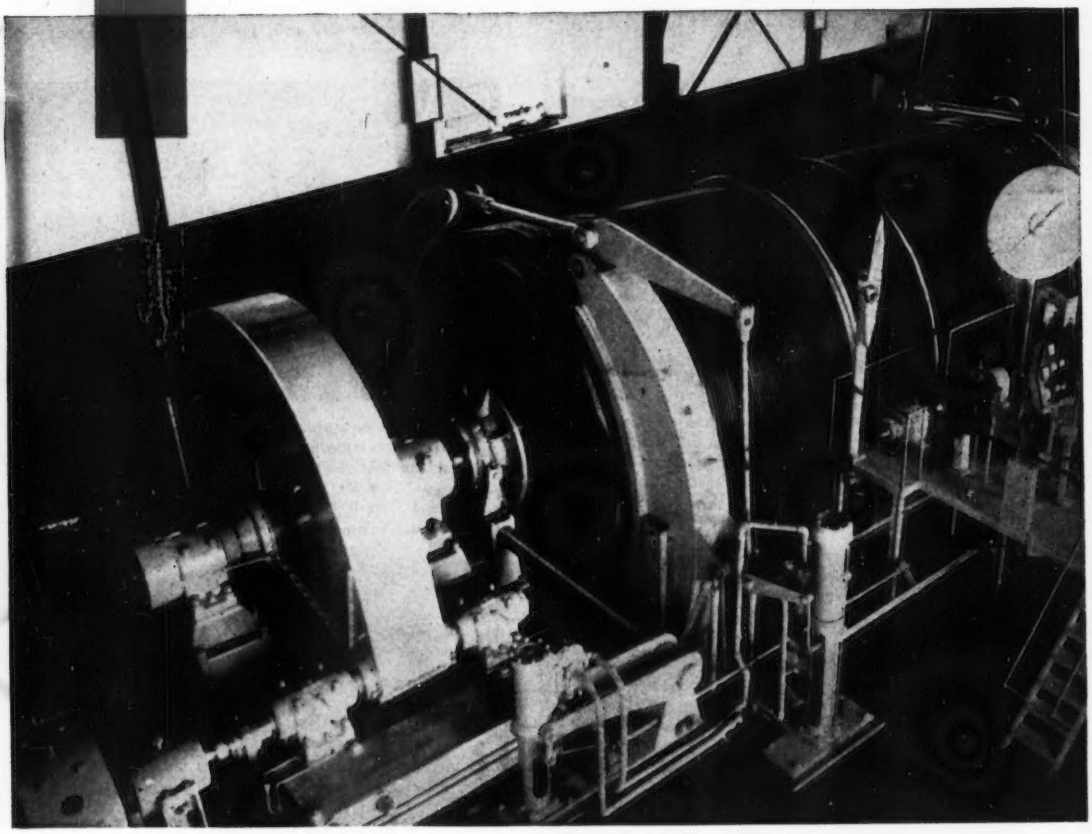
MINE STAY STRONG



TEXACO

TEXACO

7 CABLES LONGER ...when lubricated with TEXACO CRATER

Your wire rope lubricated with *Texaco Crater* gets protection against wear, rust and core rot. *Texaco Crater* wards off wear by thoroughly lubricating each strand. It guards against rust even when rope is continually in and out of water. And it *penetrates* the rope to surround and preserve the core. *Texaco Crater* is easy to apply and *its protection lasts!*

Texaco Crater stays on gear teeth as a tough, long-lasting film that carries heavy loads, cushions shocks, reduces noise and wear. You'll get longer gear life, reduce your maintenance costs. For ease of application, use *Texaco Crater Fluid*—no heating necessary.

To reduce car wheel maintenance costs, lubricate with *Texaco Olympian Grease.* You can use it in all types of car wheels and be sure of easier starts, summer and winter . . . smoother operation the year 'round.

A Texaco Lubrication Engineer can be a great help in keeping your machinery running at its best and reducing your maintenance costs. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

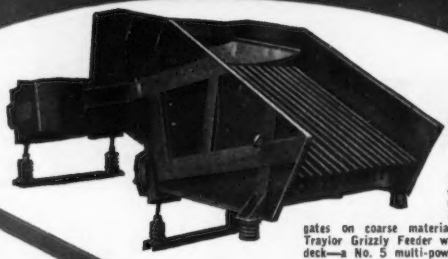
More copper mining equipment in the U. S. is lubricated with Texaco than with any other brand

Lubricants and Fuels

FOR THE MINING INDUSTRY

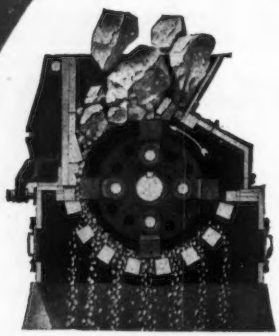
JEFFREY Equipment for

MATERIAL HANDLING



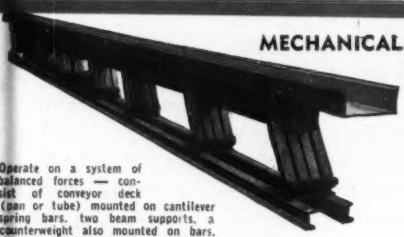
GRIZZLY FEEDERS

Provide feeder and non-clogging grizzly in single unit. Save headroom and eliminate troublesome gates on coarse material. Shown is a Jeffrey-Traylor Grizzly Feeder with 5' wide and 8' long deck—a No. 5 multi-power unit.



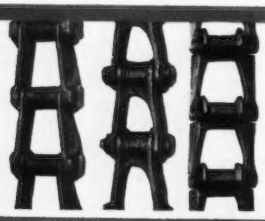
PULVERIZERS AND CRUSHERS

A complete line . . . a type and size for most any reduction requirement. Single, Double Roll, FLEXTOOTH, and Mud Hog Crushers; Rigid and Swing Hammer Pulverizers; Rock Busters, etc. Catalog No. 837 describes and pictures the entire line.



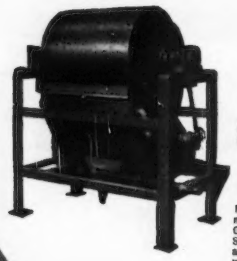
MECHANICAL VIBRATING CONVEYORS

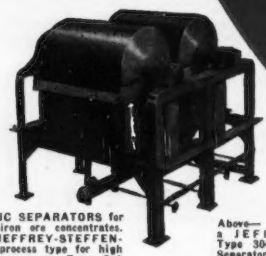
Operate on a system of balanced forces — consist of conveyor deck (pan or tube) mounted on cantilever spring bars, two beam supports, a counterweight also mounted on bars, and the drive. Handle abrasive, lumpy or rough materials, hot or cold, dry or wet—also finer and softer materials.



CHAINS

A full line of malleable iron, steel and SUPERMAL Chains for every conveying, elevating and driving need. Sprockets, attachments as well as bearings, take-ups, idlers, traction wheels, etc.





MAGNETIC SEPARATORS for magnetic iron ore concentrates. Of the JEFFREY-STEFFENSEN wet-process type for high and clean recovery. Type C-2 wet type Magnetic Cobber (left)

Above—a JEFFREY-STEFFENSEN Type 3040 two-drum Magnetic Separator. Also three-drum types.

The JEFFREY MANUFACTURING Company

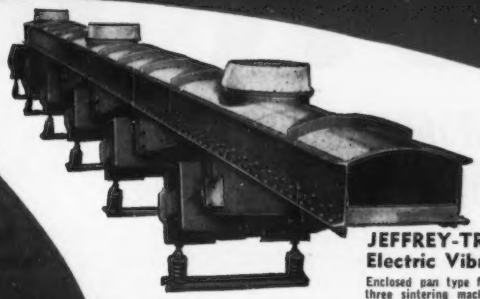
974 North 4th Street

Columbus 16, Ohio

Sales Offices in Principal Cities

Modern Metal Mine Operation

PROCESSING VENTILATING

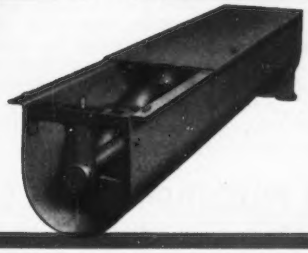


JEFFREY-TRAYLOR
Electric Vibrating Conveyor

Enclosed pan type for handling hot return sinter fines. Unit shown serves three sintering machines. Deck is 25" wide x 45' long—has three feed inlets. Also Feeders, Screens and Weigh-Feeders.

BELT CONVEYORS

Furnished in troughing and flat belt types in widths from 14" to 60". A complete line of Idlers for use with Belt Conveyors for moving large tonnages over great distances. Standard type troughing with standard return Idler is shown. Also Impact Absorption Idlers with rubber rolls; Self-aligning troughing and return Idlers; Rubber-covered Spool return Idlers, etc. Send for Catalog No. 785.

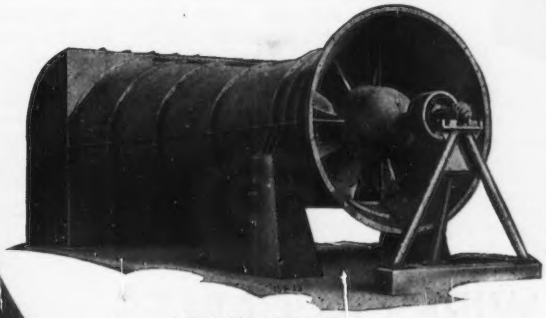


SPIRAL CONVEYORS

The Jeffrey Spiral Conveyor is adapted to handling many materials—used extensively as a processing unit as conveyor and feeder. Can easily be made dust tight.

A type and size bucket elevator (right) to meet your need exactly—with or without casings, spaced or continuous buckets mounted on chain or belt.

BUCKET ELEVATORS



AERODYNE FANS

Provide the highest efficiency in ventilation—a range of sizes to meet capacity requirements up to 500,000 C. F. M. are available. Insure an abundant supply of fresh air when and where needed most.

OTHER EQUIPMENT

Car Pullers
Coolers
Dryers
Packers
Stackers (belt)
Drills
Transmission Machinery
Bin Valves
Bin Level Controls
Feeders
Screens
Weigh-Feeders
Shuttle Cars

LOOK to

for OUTSTANDING NEW ADVANCES IN MINE CABLE DESIGN...

For Instance: Recently the Simplex Research Team developed and perfected the following three cables designed to increase the efficiency of shuttle car service, of high-voltage power systems, and of signal, control, and communications circuits:

SIMPLEX-TIREX TWIN SHUTTLE CAR CABLES

Feature **Gear-Shaped** insulated conductors that firmly interlock with the jacket so that even continual twisting of the cable will seldom pull them out of position. They will not twist or override each other. The Selenium Neoprene Armor is CURED-IN-LEAD for extra toughness and bears approval of the U. S. Bureau of Mines and the Pennsylvania Dept. of Mines (No. P-101BM). Available as Type W and Type G.

SIMPLEX-ANHYDREX XX CABLES

High-voltage cables that assure uninterrupted service at 2,000-17,000 volts operation in underground, duct, or aerial installations. Insulated with Anhydrex XX, first high-voltage insulation combining all the properties necessary for trouble-free operation when exposed to water and moisture, heat, ozone, and other deteriorating agents. Jacketed with a special neoprene compound that provides steadfast protection against rough handling, soil acids and alkalies, oils, grease, chemicals and flame.

SIMPLEX POLYETHYLENE-PLASTEX CABLES

Lightweight, small-diameter cables for signal, control, and communication circuits. Polyethylene insulation features thin wall, high dielectric strength, high insulation resistance and low water absorption. Its low power factor and low dielectric constant assure maximum signal strength. Plastex jacket is resistant to oxidation, flame, oil, water, sunlight and weathering. It is usable over a temperature range of about 200 degrees Fahrenheit and it resists cracking down to —58°F. Available in three types adapted to underground, duct, conduit, and aerial installation.

SIMPLEX WIRES & CABLES

SIMPLEX WIRE & CABLE CO., 79 SIDNEY ST., CAMBRIDGE 39, MASS.

SIMPLEX

plus A COMPLETE LINE OF PERFORMANCE-PROVED CABLES FOR EVERY MINE USE...

SERVICE	USE	SIMPLEX PRODUCT
MINING	Electric Drills	TIREX SO Cord. TIREX Heavy Duty Mine Cord.
	Shot Firing	TIREX Shot Fire Cord (Round). Simplex Shot Fire Cord (Twin).
	Shuttle Cars	TIREX Special Shuttle Car Cable (see opposite page).
	Shuttle Cars, Cutters, Loaders	TIREX Twin Mining Cable; Type W, without ground wires; Type G, with ground wires. Also TIREX 3-Conductor Round Cable, Type W.
	Locomotives	TIREX Locomotive Cable; steel reinforcing strands in conductor.
	Shovels and Draglines	TIREX High-Voltage Cables; Types W, G, SH-A, SH-B, SH-C, SH-D.
		All TIREX Cords and Cables are jacketed with CURED-IN-LEAD Selenium Neoprene Armor. All stock sizes for mine use have approval, No. P-101, of the Dept. of Mines, Comm. of Pennsylvania.
MINE EQUIPMENT	Air Compressors (Portable)	TIREX Twin Cables, Types W and G. TIREX 3-Cond. Round Cable, Type W.
	Air Compressors (Stationary) Ventilating Fans Mine Pumps Car Pullers	Anhydrex or Anhydroprene Cables. Both feature the exceptional moisture resistance of Anhydrex insulation and the durability of a neoprene jacket. Anhydrex cables can be installed directly in earth, in conduit, and in air. Anhydroprene cables, with lighter jacket, should not be buried directly in earth.
	Track Signal Systems	Anhydrex Multi-Cond. Signal Cable. Polyethylene-Plastex Signal Cable (see opposite page).
	Telephone Systems	Anhydrex Mine Telephone Cable.
COAL PROCESSING EQUIPMENT	Washhouse Wiring	Anhydroprene Wires.
	Crushers	Anhydrex Cables. Anhydroprene Cables.
	Vibrator Screens	TIREX SO Cords. Anhydrex Cables.
SHOPS	Machine Tools	TIREX SO and SJO (light service) Cords. Plastex Machine Tool Wire; available with light, heavy and extra-heavy insulation.
	Welding Machines Electrode Cable	TIREX Super-Flexible Welding Cable.
	Electrode Return	TIREX Single Conductor Cable.
	Welding Machines Power Side	TIREX 2 and 3-Conductor Cables.
	Locomotive Wiring	TIREX Motor Lead Cable.
	Battery Charging	TIREX Twin and TIREX Round Type W Cables.
POWER AND LIGHTING	Aerial Distribution Systems	Anhydrex, Varnished Cambric, and Paper Insulated Cables — available with built-in messenger or messenger can be applied in field by Spinner.
	Underground Distribution Systems	Anhydrex Cables; provide resistance to water and moisture, soil acids and alkalies, have no metallic sheaths to crystallize and corrode.
	Boreholes and Shafts	Anhydrex Cables and Varnished Cambric Cables — available with a wide choice of outer coverings to meet the requirements of all methods of suspension.
	Sub-Surface Distribution	Anhydrex Feeder Cables, Varnished Cambric Feeder Cables.
	Switchboard Wiring	Anhydroprene Wires, Plastex Wires.
	Yard Floodlighting	Anhydrex Cables.

Write for Catalog 1008, "Simplex Cables for Mining"

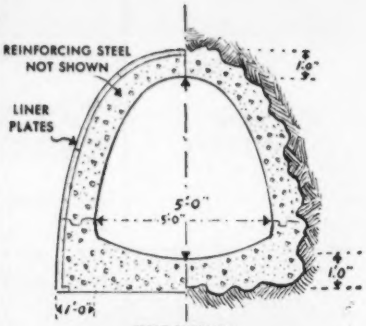
CASE HISTORY OF A SUCCESSFUL TUNNEL JOB

FROM THE EIMCO FILE T289

PAWTUCKET SEWAGE TUNNEL

Specifications

Tunnel length 2400'—Diameter approximately 6' rough bore. Advance approximately 2—5' rounds per heading per shift in rock sections. Liner plates used in soft sand sections. Working 5 headings. Loaders — Eimco Model 12B low head room modified for 5'6" headroom clearance.



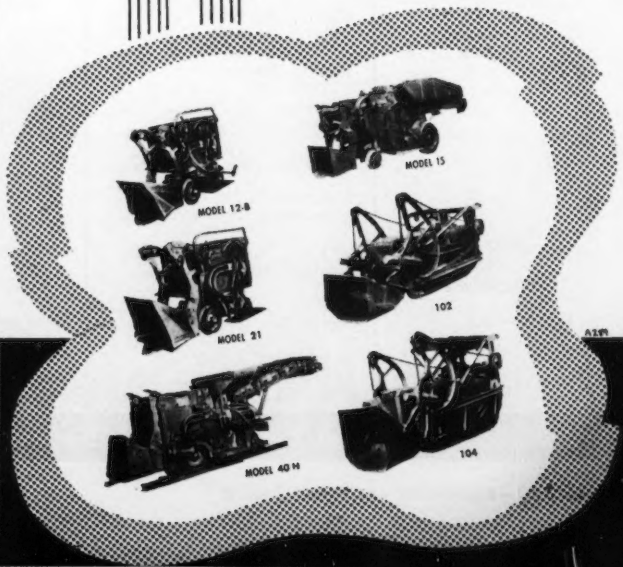
HALF SECTION

IN EARTH OR LOOSE ROCK — IN SOLID ROCK

Modern contractors insist on dependable equipment to help them make a profit on highly competitive jobs. Big or small rock loading jobs are equally important in this respect. Each job is different in many respects and in order to work it successfully it must be individually handled.

All this is known to the Eimco engineer who has lived with rock handling jobs and given many contractors the information of his years of experience. Many other little things that add up to success are also suggested with his able assistance.

For instance: an efficient coupler will in many cases increase loading speed by as much as 25% per car. Eimco always designs a coupler for the customer's car at no extra charge—just one of the little services that improve the speed, efficiency and dependability of Eimco Rocker-Shovels.



EIMCO

THE EIMCO CORPORATION

The World's Largest Manufacturers of Underground Rock Loading Machines

EXECUTIVE OFFICES AND FACTORIES — SALT LAKE CITY 10, UTAH, U. S. A.

BRANCH SALES AND SERVICE OFFICES:

NEW YORK, 51-52 SOUTH STREET • CHICAGO, 3319 SOUTH WALLACE STREET
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EL PASO, TEXAS, MILLS BUILDING • BERKELEY, CALIFORNIA, P. O. BOX 240
KELLOGG, IDAHO, 307 DIVISION STREET

IN FRANCE: SOCIETE EIMCO, PARIS, FRANCE
IN ENGLAND: EIMCO (GREAT BRITAIN) LTD., LEEDS 12, ENGLAND
AGENTS IN ALL PRINCIPAL CITIES THROUGHOUT THE WORLD

Why the NORTHWEST is a BETTER MINING SHOVEL!

BETTER TRAVEL

The Northwest Steering is smoother — easier on operator and machine with *positive* traction on *both crawlers* while turning as well as when going straight ahead.

BETTER CONTROLS

The "Feather-Touch" Clutch Control gives easy operation. It is free from complications or sensitive mechanism. No special servicing is ever required and manual control can be had on the instant.

BETTER SWING CLUTCHES

Uniform Pressure Swing Clutches that grip easily, are free from jerks and grabs that make spotting the load difficult and waste digging time.

THE Northwest is a real Rock Shovel proved in hard rock work. Greater simplicity in design makes maintenance easier. Unusual mobility as compared with other crawler designs saves time clearing for shots. Fast swing and high capacity under many conditions improves output over larger equipment. The Helical Gear Drive gives smooth trouble-free transmission of power. Cast Steel Bases and Machinery Side Frames are ruggedly built and maintain shaft alignment and Ball and Roller Bearings on all high-speed shafts cut power losses to the minimum.

In the Northwest you have a combination of advantages not found in any other shovel size for size—advantages that mean greater output and lower cost operation.

BETTER CROWD

The Northwest Dual Independent Crowd utilizes force most other independent crowds waste assuring the handling of tough digging with greater output.

CUSHION CLUTCH

Reduces shock overloads of heavy digging before they can damage machinery.

NORTHWEST ENGINEERING COMPANY
1509 Field Building • 135 South LaSalle Street • Chicago 3, Illinois

NORTHWEST

Convertible for any Mining Material Handling or Excavation Problem

3 New Tools at the service of the mining

the DorrClone*

for the separation of finely divided solids in liquid suspensions

The DorrClone is a compact cylindro-conical classification unit utilizing centrifugal force in place of gravity. Because of its remarkable capacity-for-size and its ability to handle flocculent pulps it constitutes an important new tool with which to supplement current established practices.

Typical commercial applications proven to date include . . .

- beneficiation of iron ore
- desliming and recovery of fine coal
- degritting of milk of lime and clay slurries
- desliming of concentrated tailings
- desliming and maximum recovery of phosphate fines
- dewatering mine fill from deslimed mill tailings

FluoSolids*

for the economical production of high-strength SO_2 from sulphides

Curtailment of strategic production because of the shortage of elemental sulphur faces sulphuric acid manufacturers and all users of sulphur dioxide. FluoSolids presents an economically feasible means of tapping iron pyrites and copper and zinc sulphides as an alternate source of SO_2.

Utilizing the principle of fluidization, the Dorrco FluoSolids System is a distinct departure from conventional roasters. It brings SO_2 production from these sources down to a reasonable investment and operating cost-level.

With FluoSolids . . .

- gas strength will average 14 to 15% SO_2 dry basis from pyrite carrying 48 to 50% sulphur
- gas cleaning equipment is smaller . . . because of lesser gas volumes
- feed may be relatively coarse . . . flotation concentrate

in Ion-Exchange

Dorrco d-i* Systems . . . for boiler feed water treatment . . . for the recovery of valuable metals from dilute solutions

Dorrco ***d-i*** Systems are available in a complete range of types and sizes to fulfill any need of the mining industry involving ion-exchange. The comprehensive Dorr service for the study and handling of ion-exchange problems of all kinds includes:

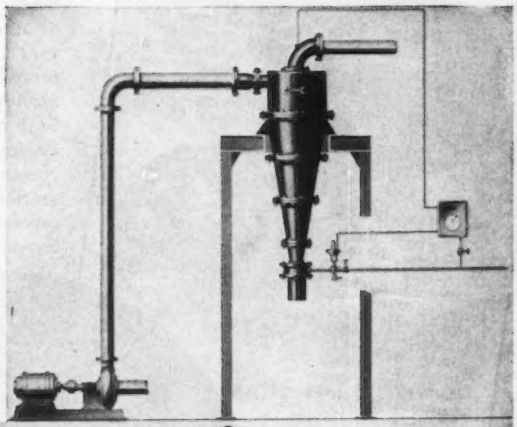
- laboratory testing
- evaluation of test results and recommendation of process
- design of plant . . . including piping,

industry... to help meet the demands of a mobilized economy

- desliming and maximum recovery of fine sand fractions
- classification in closed-circuit-grinding systems
- size separation of crystals
- separation of coarse aluminum hydrate
- dewatering table concentrates and barytes

DorrClones are now available singly or in multiple arrangements in four standard sizes: 3″, 6″, 12″ and 24″ diameters. We welcome inquiries on specific problems and applications and are prepared to undertake engineering investigations within the scope of our present knowledge and experience.

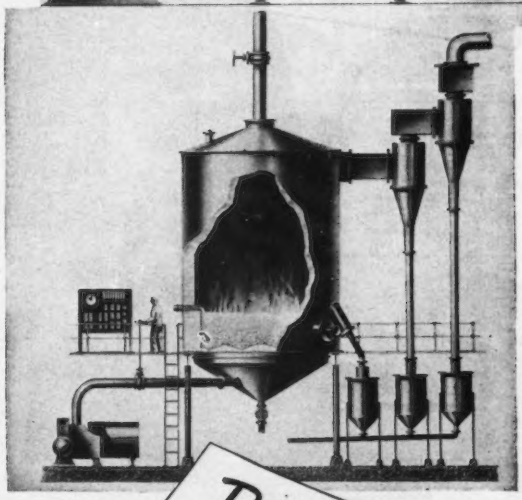
Only the DorrClone has the Vactrol feature, which automatically insures constant discharge density . . . one of the demonstrated developments that makes the DorrClone capable of controlled and predictable operation.*



to 35 mesh—jig or table concentrate to 14 mesh

- maintenance is minimum . . . no moving parts exposed to high temperature . . . long refractory life
- scaling is eliminated . . . temperature is accurately controlled below fusion point
- no extraneous fuel is needed once fluidized bed is up to calcining temperature
- process shut-downs of two or three days present no roasting problem
- complete instrumentation eliminates the personal factor in operation

These facts are indicative of the economy, simplicity and ease of operation obtainable with FluoSolids. For more detailed information write for Bulletin 7500, "FluoSolids Roasting of Sulphides."



instrumentation and electrical and foundation layout

- erection instructions and supervision
- supervision of initial operation
- instruction of operators

All or any part of this completely flexible service may be utilized on a given problem . . . whether it involves boiler feed water treatment or the extraction and concentration of valuable metals from dilute solutions.

Bulletin 4081 covers the scope of our work in the broad field of ion-exchange. A copy is yours for the asking.

* DorrClone, Vactrol, FluoSolids and *d-l* are trade-marks of The Dorr Company.

R R

RESEARCH · ENGINEERING · EQUIPMENT

THE DORR COMPANY · ENGINEERS · STAMFORD, CONN. · Associated Companies and Representatives in the principal cities of the world

STURTEVANT

Dustless BLENDERS

Produce Perfectly Mixed Products with NO Loss of Materials

RECEIVING

The ingredients to be mixed enter the mixing chamber of the drum through a chute. Note scoops which carry up and dump the ingredients as the drum rotates.

DISCHARGING

By simply throwing a lever, the inlet is closed and the mixer is in discharging position. The completely mixed materials drop off the lifting scoops and discharge through chute without segregation of ingredients.

Four-way mixing action produces homogeneous blends. No matter what the densities, weights, finenesses or other physical properties of the ingredients, Sturtevant Dustless Blenders provide *a thoroughly blended product* with no substances floating to remain unmixed. Sturtevant advantages include—single opening for both receiving and discharging . . . "open door" accessibility for quick, thorough cleaning . . . rugged construction for long life and minimum maintenance. Sturtevant Dustless Blenders are available in mixing capacities from 500 to 20,000 pounds. Write for information or engineering assistance.

STURTEVANT MILL COMPANY
100 CLAYTON STREET, BOSTON 22, MASS.

Designers and Manufacturers of

CRUSHERS • GRINDERS • SEPARATORS • CONVEYORS
MECHANICAL DENS and EXCAVATORS • ELEVATORS • MIXERS

TOPS for ROCKS

You need it today more than ever before—this super-tough champ that gives longest tire life, greatest economy on even the toughest rock jobs.

It's Goodyear's Hard Rock Lug, of course—the tire that's specially designed to give you dependable performance now and for a long time to come.

Outstanding features like these make the Hard Rock Lug a favorite of cost-wise mine and quarry operators:

Extra-tough carcass protected against bruising by an extra-thick undertread. Big, tough lug bars armor its tread and sidewalls against cuts and rips. Provides exceptional traction, forward or reverse, with its self-cleaning tread.

Make your tire dollar go miles farther. Remember always to BUY and SPECIFY Goodyear—*it pays!*

HARD ROCK RIB

Companion tire for front wheels in rock work—easier steering, smooth rolling, same cord body, same shoulder and sidewall as Hard Rock Lug

ROAD LUG

Remarkable dual-purpose tire operates both OFF and ON the road. Combines off-the-road toughness and traction with on-the-road mileage and economy

Road Lug—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio.

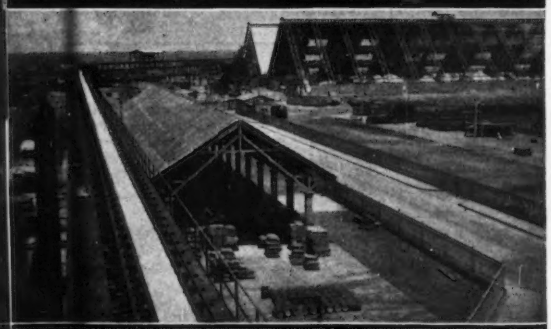
GOODYEAR

MORE TONS ARE HAULED ON GOODYEAR TIRES THAN ON ANY OTHER KIND

MODERNIZED Port of Iquique

speeds shipping
simplifies handling
cuts mine-to-market costs

It takes only a few minutes for bridge crane to pick up gondola cars bodily and unload their 35 tons of nitrate into a conveyor hopper. Plant easily unloads 7 cars per hour, ample for mine output under present coordinated rail schedule.



From car unloader to ship, handling is 100% conveyor equipped. Bridge crane hopper feeds to a belt conveyor (left) which delivers the nitrate to shuttle conveyors mounted under the roofs of the two storage plants shown at the upper right.

From the storage plants, conveyor system with capacity of 606 tons per hour, transfers the bulk nitrate and loads it into ships for low cost sea voyage to ports all over the world. Automatic bagging facilities are also available.

# of Chilean Nitrate

When the new Nitrate Storage and Shipping Plant of Iquique, Chile, was opened last year under the auspices of the President of the Republic, it meant a great deal to the government, the mines, and the people of Chile in improving their world marketing position on a product of great importance to their national economy.

In its first year of operation, these new and very modern facilities, costing nearly $2,000,000, have shown their ability not only to reduce costs, but also to speed and simplify delivery of Chilean nitrate to world markets.

Major economies were made in:

1. Transferring storage from inland production plant to port, so that peak loads of railroad transportation and loading delays can be avoided and costs reduced.

2. Mechanized unloading, storage, and reloading-to-ship operations utilizing a complete system of belt conveyor transportation so that handling costs are materially lowered.

3. Faster loading and adequate port storage that shortened ship time at dock, and eliminated ship delays waiting for nitrate, resulting in a considerable reduction in ocean shipping costs.

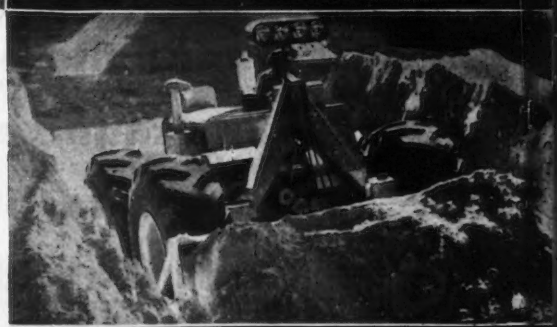
LE TOURNEAU

Modern high-speed LeTourneau Tournadozer spreads nitrate from conveyor discharge in the storage plant, rehandles it for delivery through hatchways to the dock conveyor. Blade carries average of 2½ cubic yards of bulk material with each pass.

Tournadozer speeds bulk storage

The two modern storage plants at Iquique have capacity to store 88,200 tons of bulk nitrate. In these plants a modern rubber-tired LeTourneau Tournadozer speeds spreading of the nitrate for maximum storage capacity and also pushes it through hatchways in the floor to a belt conveyor system that discharges the nitrate into the holds of cargo ships docked at the pier.

This modern Storage and Shipping Plant for the Port of Iquique was constructed and is operated by the Compania Salitrera de Tarapaca y Antofagasta for the Chilean Nitrate Sales Corporation.



Giant rubber tires (6 ft. in diameter) protect the concrete floors. This dozer on rubber can also do emergency hauling and maintenance around port and plant. It can go anywhere at speeds to 19 m.p.h., across tracks, over curbs, on pavement, or cross country.

Other mining uses

In addition to materials handling, the mobile 19 m.p.h. Tournadozer also speeds shovel clean-up, dozes overburden, clears haul roads, switches railroad cars, pulls heavy equipment, etc. On all this work, Tournadozer's faster-than-crawler speeds, in both forward and reverse, increase production and cut costs. Let your LeTourneau Distributor show you how one Tournadozer can do the work of 2 to 3 conventional crawler dozers on your mining jobs. Write, or call him TODAY.

Tournadozer—Trademark Reg. U.S. Pat. Off.

High speed reverse (approximately twice that of most crawlers) is an important time saver on this type of shuttling. Constant-mesh transmission gives instant speed selection and eliminates shifting delay and also saves vital rolling momentum.

JOB-PROVED

TOURNADOZERS

JOY MACHINES

Field-Proved in Service

Made by the world's largest manufacturer of Underground Mining Equipment, and the pioneer in mechanized mining, JOY Equipment can give you the great advantage of

MORE PRODUCTION AT LESS COST

The JOY Line is COMPLETE

Note, in the comparison below, how JOY EQUIPMENT stands out in its ability to take care of Metal Mine Requirements

	JOY	Company B	Company C	Company D	Company E	Company F	Company G	Company H
ROCK DRILLS								
Spaders						NO		
Busters						NO		
Jack Hammers						NO		
Stopers						NO		
Drifters						NO		
Drill Jibs					NO	NO	NO	
Drill Jumbo (Track)			NO	NO	NO	NO	NO	
Drill Jumbo (Trackless)		NO	NO	NO	NO	NO	NO	NO
DRILL BITS								
Carbide Bits			NO	NO	NO	NO	NO	NO
Detachable Bits	NO		NO	NO	NO	NO	NO	NO
Thro-Way Bits		NO	NO	NO	NO	NO	NO	NO
HOISTS								
Single Drum Utility					NO	NO	NO	NO
Single and Two Drum Shaft		NO	NO	NO	NO	NO	NO	NO
Two Drum to 15 HP				NO	NO	NO	NO	NO
Two Drum to 125 HP			NO	NO	NO	NO	NO	NO
Three Drum to 15 HP				NO	NO	NO	NO	NO
Three Drum to 125 HP			NO	NO	NO	NO	NO	NO
Sheaves		NO	NO	NO	NO	NO	NO	NO
CORE DRILLS								
Exploratory—Underground			NO		NO	NO	NO	NO
Exploratory—Surface			NO		NO	NO	NO	NO
Contract Core Drilling		NO	NO	NO	NO	NO	NO	NO
ROTARY BLAST HOLE DRILLS								
Underground—Small Hole			NO		NO	NO	NO	NO
Surface—Air Jet—Large Hole		NO	NO	NO	NO	NO	NO	NO
COMPRESSORS								
Portable						NO	NO	
Vertical—Air Cooled						NO	NO	
Vertical—Water Cooled						NO	NO	NO
Large Heavy Duty						NO	NO	NO
LOADERS								
Scraper Slides			NO	NO	NO	NO	NO	NO
Mine Car Type		NO		NO	NO		NO	NO
Trackless Loaders (Medium)		NO	NO	NO	NO		NO	NO
Trackless Loaders (Heavy)		NO	NO	NO	NO	NO	NO	NO
MATERIAL HANDLING								
Shuttle Cars		NO	NO	NO	NO	NO	NO	NO
Chain Conveyors		NO	NO	NO	NO	NO	NO	NO
Shaker Conveyors		NO	NO	NO	NO	NO	NO	NO
Belt Conveyors		NO	NO	NO	NO	NO	NO	NO
MINE VENTILATION								
Portable Blowers, Electric		NO	NO	NO	NO	NO	NO	NO
Portable Blowers, Air		NO	NO	NO	NO	NO	NO	NO
Large Mine Fans		NO	NO	NO	NO	NO	NO	NO

WRITE FOR BULLETINS, OR *Consult a Joy Engineer*

W&D M2572

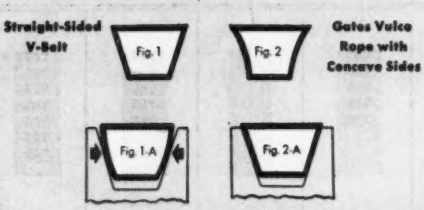
JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

Here is *Exactly WHY* a V-Belt with CONCAVE SIDES Gives You *Longer Wear!*

What Happens When a V-Belt Bends



How Straight-Sided V-Belt Bulges In Sheave-Groove. Sides Press Unevenly Against V-Pulley Causing Extra Wear At Point Shown by Arrows.

The Concave Sides Fill Out to a Precise Fit in the Sheave Groove. No Side Bulge! Sides Press Evenly Against the V-Pulley — Uniform Wear — Longer Life!

To see for yourself how a V-Belt that has *concave sides* is certain to give longer wear, just make this simple test:—

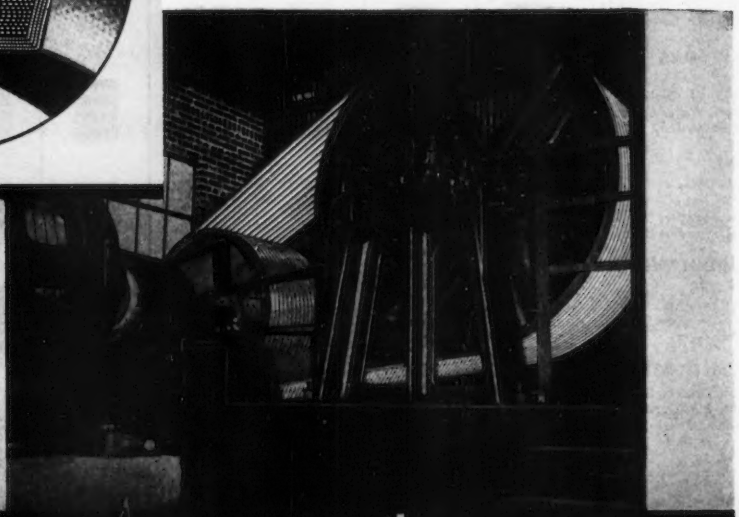
Pick up any V-Belt you have at hand. Bend that belt as it bends around a pulley. As it bends, grip its sides between your fingers. Here is what will happen *everytime*.

If the V-Belt you are testing has *straight sides*, you can feel those sides *bulge out* as the belt bends. This out-bulge forces the sides of the belt to press *unevenly* against the V-Pulley and you naturally get *concentrated* wear just where the bulge is greatest—as shown in figure 1-A, at left.

Now, make this same test with the belt that is built with *Concave Sides*—the Gates Vulco Rope!

Whereas you felt an *out-bulge* when you bent a belt with straight sides, you find that the *Concave Sides* merely fill out and become *perfectly straight*. The sides therefore *press evenly* against the V-Pulley. This distributes the wear *uniformly* across the *full width* of the belt. Naturally, this means longer belt life and *lower* belt *costs* for you!

Only V-Belts made by Gates are built with concave sides. Whenever you buy V-Belts, be sure that you get the V-Belt with the Concave Sides—The Gates Vulco Rope!



Gates Vulco Rope Drive on the Mine fan of Sloss Sheffield Steel & Iron Company, Birmingham, Alabama. The drive operated 24 hours a day for 3 years without down-time.

CS-517

Gates

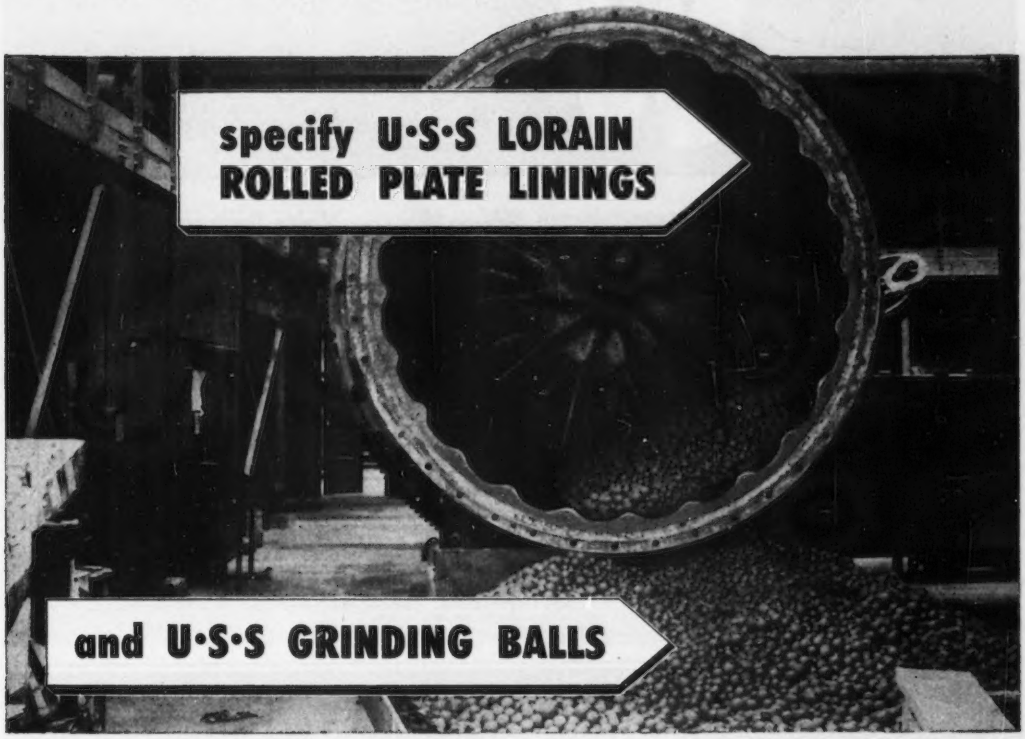
Hose — V-Belts
Molded Rubber Goods
for Industry

VULCO ROPE **DRIVES**

ENGINEERING OFFICES AND JOBBER STOCKS
IN ALL INDUSTRIAL CENTERS

THE GATES RUBBER COMPANY
DENVER, U. S. A.
The World's Largest Makers of V-Belts

For lower grinding costs, higher grinding efficiency...



U·S·S LORAIN ROLLED PLATE LININGS are designed for quick, easy handling . . . save hours of installation labor, keep mill down-time to a minimum. And the rugged strength of the rolled steel from which Lorain Linings are made enables you to use a plate of reduced thickness . . . thereby increasing usable diameter of your mill, boosting output.

The use of U·S·S Lorain Linings means economy in maintenance of both shell and lining. Tight joints between liner plates and lift bars eliminate shell wash and allied troubles. Liner plates may be worn paper thin without breakage. Plates are made interchangeable—and severe localized wear at feed or discharge ends may be balanced by shifting plates. Through such features you get *all* the life out of the lining.

There's a length, diameter and thickness of Lorain Plate to fit any type of mill. Available through leading mill manufacturers whose names will be furnished upon request.

U·S·S GRINDING BALLS help to make better, more economical grinding doubly sure. For they're forged from special analysis steel and are accurately heat-treated to take the punishment of the longest, heaviest runs. Available in sizes from ¾" to 5" in diameter. For complete information about long-lasting U·S·S Grinding Balls send for our new booklet. No obligation, of course. Just return the convenient coupon below.

United States Steel Company
Room 4258
525 William Penn Place
Pittsburgh 30, Pa.

Without obligation on my part, please send me your FREE booklet on U·S·S Grinding Balls.

Name.....

Company.....

Address.....

City.....State.....

UNITED STATES STEEL COMPANY, PITTSBURGH • COLUMBIA STEEL COMPANY, SAN FRANCISCO
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S LORAIN ROLLED PLATE LININGS and U·S·S GRINDING BALLS

1-907

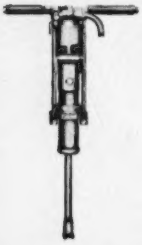
UNITED STATES STEEL

W

DRILLING

Worthington *Blue Brute* Mining Drills and Tools . . .

Built rugged for long life—balanced for easy handling



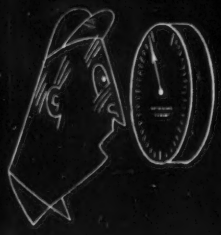
Hand-held rock drills . . . Available with hand or motor feed mountings. Worthington's efficient jet valve.

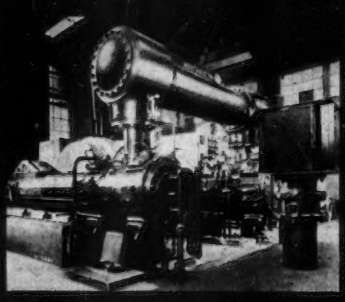
Drifters . . . 3, 3½, 4 in. Special "Pneu-Motor" on shell or drifter (also hand crank).

Stopers . . . Operating Handle well above center of gravity for easy handling. Positive, sleeve-type valve—minimum wear.

Clay diggers . . . Built-in ease of handling helps operators get more work done with less fatigue.

Breakers . . . Hard-hitting tools with soft rubber grip handles for dampening vibration.





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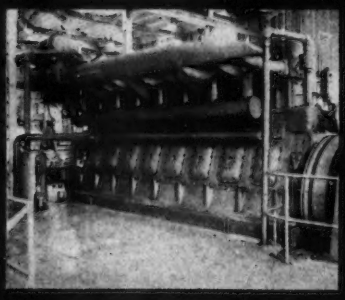

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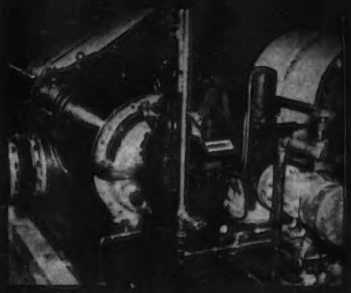

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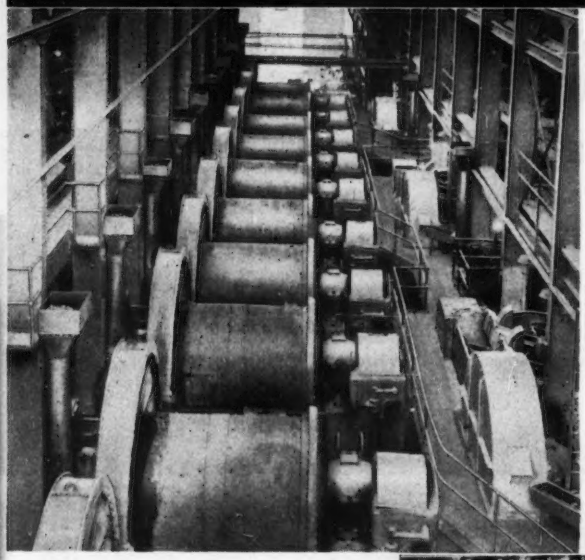
PLUS

WORTHINGTON

Mill Conversion with MARCY GRATES Increases Tonnage and Lowers Costs

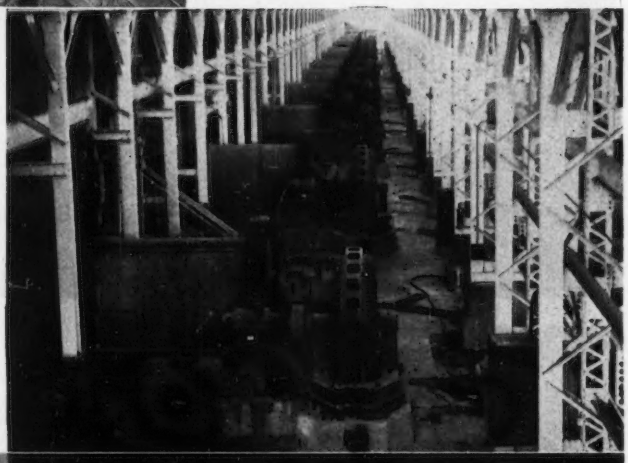


Modernization of trunnion overflow ball mills is one practical way of boosting mineral production for defense. Conversion involves only the removal of the old discharge heads and fitting the mill with new MARCY grate discharge heads. This lowers the pulp line, permits thicker pulp, speeds circulation of mill content and removal of finished product, improves power utilization and grinding efficiency.

Our Marcy engineers have made this conversion for two large copper concentrators, among others, and are prepared to give you comparative production figures on mill conversion. Ask for consultation on your production problem.

Now Ready for Distribution:

A revised up-to-date edition of our General Ore Milling Catalog. If you have use for metallurgical and milling equipment, write for Catalog No. 108-B.



Other MASSCO products: Massco-Fahrenwald Flotation Machines, Genuine Wilfley Tables, Massco-McCarthy Hot Millers, Rock Bit Grinders, Density Controllers, Belt Feeders, Rubber Pinch Valves, Assay and Laboratory Supplies and Equipment, Complete Milling Plants.

The **Mine & Smelter** Supply Co.

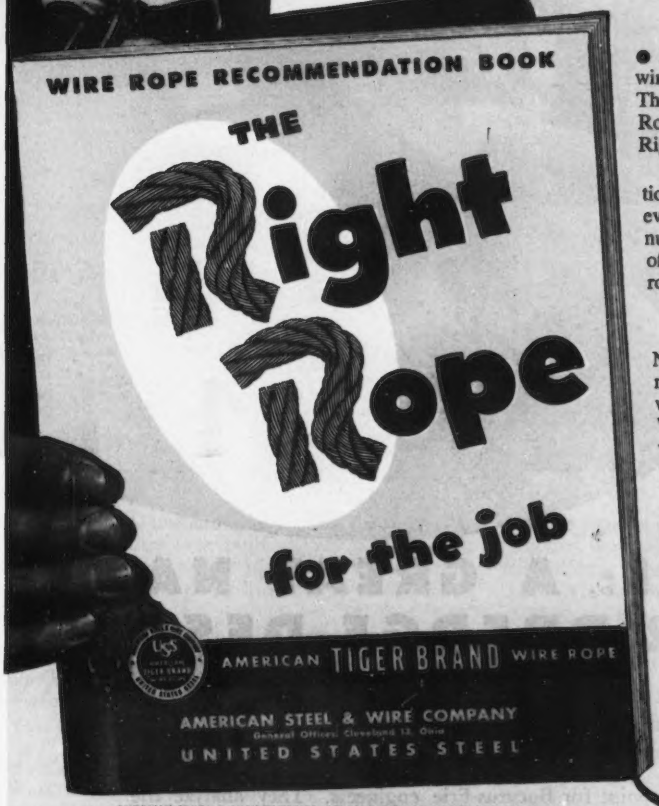
Box 5270, Terminal Annex, Denver, Colo., U.S.A.

Offices in Salt Lake City, El Paso, 1775 Broadway, N. Y. C.

Canadian Vickers, Ltd., Montreal, Can.; W. R. Judson, Santiago, Chile, and Lima, Peru; The Edward J. Nell Co., Manila, P. I.; The Ore & Chemical Corp., 80 Broad St., New York 4, N. Y., representatives for Continental Europe.

This New Book can save plenty of money for YOU!

IT SHOWS YOU HOW TO BE A BETTER BUYER OF WIRE ROPE



● Here is a book that every user of wire rope should have in his file—The American Tiger Brand Wire Rope Recommendation Book, "The Right Rope for the Job."

It covers all industries—construction, mining, petroleum, marine—even aircraft control cable. There are numerous photographs, plus listings of equipment and the types of wire rope that should be used.

For Special Applications

Naturally, there will be applications not covered in the book. For these we maintain a staff of Tiger Brand Wire Rope Specialists — engineers who can help you select the wire rope which will fit your particular needs. These men are constantly working with users of Tiger Brand Rope . . . saving them money and eliminating trouble by properly specifying wire rope.

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Please send me your Recommendation Booklet, "The Right Rope for the Job."

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UNITED STATES STEEL

IN 1895

Bucyrus-Erie installed the first successful elevator type placer dredge in the United States.

and

EVER SINCE: A GREAT NAME IN PLACER DREDGE DESIGN

TODAY, as in the "nineties," Bucyrus-Erie sets the pace in the excavating industry — ashore and afloat. Its placer dredges are typical — matched to the *job* for long-term peak performance.

Your job is the starting point for Bucyrus-Erie engineers. They analyze the character and depth of the deposit, water supply, power and transport facilities, and other conditions peculiar to a specific operation. Balancing these factors with experience unique in the industry, they produce a dredge design geared to high output at lowest possible cost.

But that's not all. Bucyrus-Erie's complete manufacturing facilities provide on-the-spot control of *all* stages of production. That means real assurance of quality in materials and workmanship to match the top-notch *years ahead* design.

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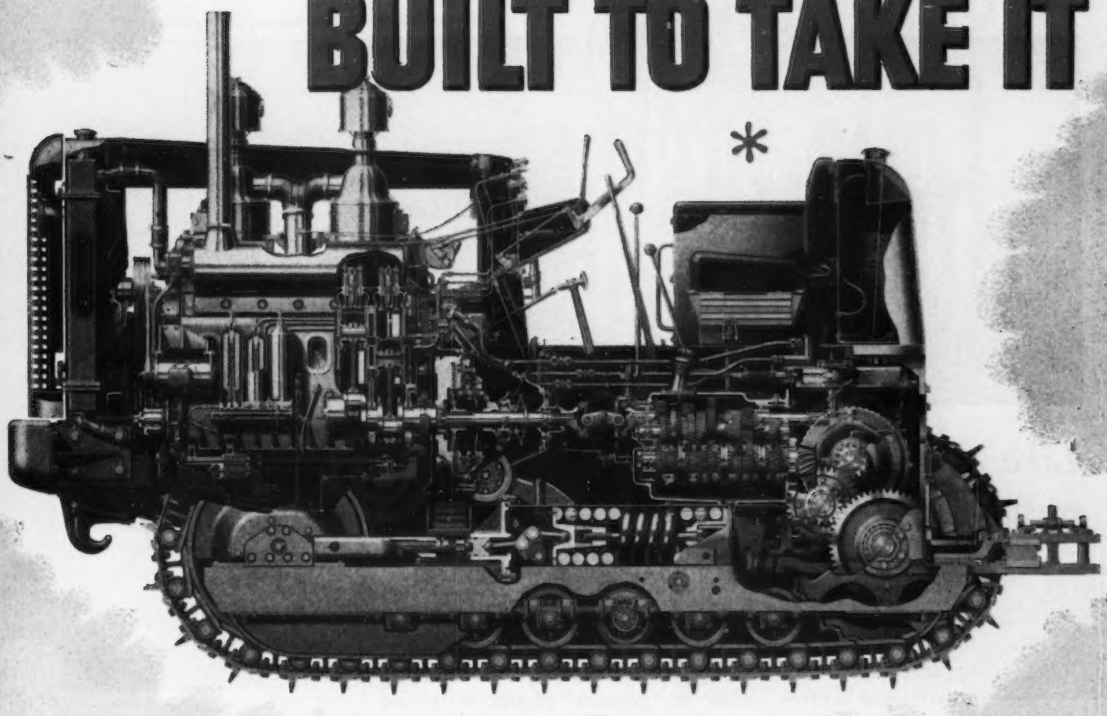
BUCYRUS ERIE SOUTH MILWAUKEE, WISCONSIN

Here's what WE mean by

BUILT TO TAKE IT



The new Allis-Chalmers tractors are the toughest, strongest tractors ever built. Every part in each of the four models has ample size and strength to do its job — not a weak link nor a compromise anywhere.

And that's no accident! To bring you tractors like these . . . with the qualities you want . . . Allis-Chalmers built 'em completely new — from the ground up.

You can depend on them to take the loads, the jolts of today's jobs . . . because they are modern tractors designed for the most grueling operating conditions. They will more than measure up to your expectations!

Here are just a few of the many reasons why this NEWEST, FINEST TRACTOR LINE ON EARTH is *Built To Take It*... besides being easy to operate, easy to service and outstanding in performance. Your Allis-Chalmers dealer will gladly explain all these advantages . . . see him NOW.

- All-Steel Welded Construction
- More Power with Bigger Engines — Longer Engine Life
- More Weight, Greater Strength
- Extra Heavy Main Frames — No Extra Reinforcement Needed for Front-Mounted Equipment
- Long-Lasting, Large Diameter Clutches
- Double Reduction, Straddle-Mounted Final Drive Gears with Live Sprocket Shafts and Caged Bearings
- Positive Operating Track Release — Works in Oil on HD-9, HD-15, HD-20
- All New, Specially Designed Track Assembly
- Positive-Seal Truck Wheels, Support Rollers and Idlers — Mounted on Tapered Roller Bearings. 1,000-Hour Lubrication!

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TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

The Newest, Finest Tractor Line on Earth!

40.26 drawbar hp.
11,250 lb.

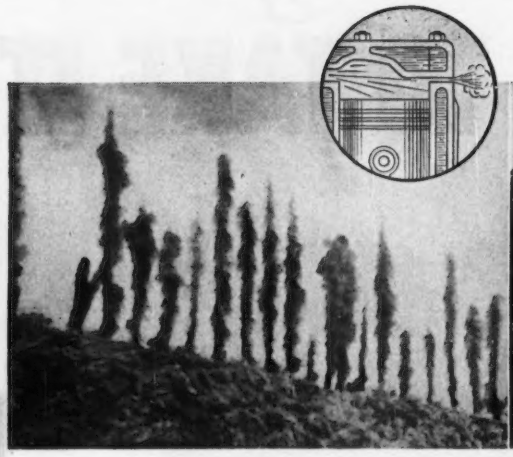
70 drawbar hp.
18,900 lb.

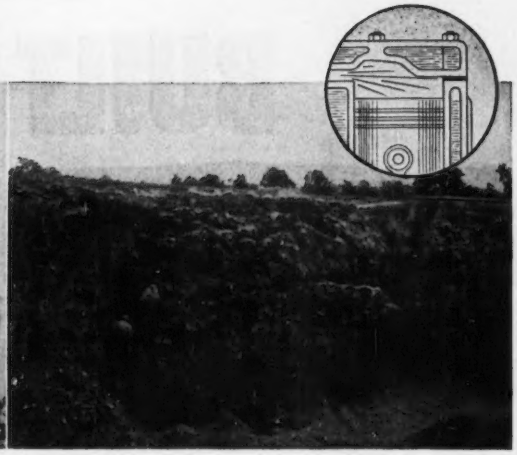
102 drawbar hp.
27,850 lb.

Hydraulic Torque Converter Drive
175 net engine hp.
41,000 lb.

- DESIGNED FOR YOUR JOB
- BUILT TO "TAKE IT"
- EASY TO OPERATE
- EASY TO SERVICE

Power Wasted! Power Working!





Like a "blown" gasket, an ordinary blast wastes the power that **ROCKMASTER** *blasting keeps on the job!*

THE HAMMER, hiss, and whistle of a "blown" gasket means a lot of power is going to waste instead of working on the piston. In the same way, the objectionable noise that often comes from blasting usually means that explosives power is being wasted instead of working on the rock. And that wasted gas is often visible as "geysers" of smoke or wild flying rock.

ROCKMASTER blasting keeps blasting power—the explosives gas—well confined and working on the rock. ROCKMASTER blasting gives a smooth flow of power that means control over breakage and throw never before possible—with far less noise and vibration!

Your job may call for two, three, or even all sixteen ROCKMASTER milli-second delay electric blasting caps. We help you select them to fit a particular job in quarry, strip pit, mine, construction . . . on the surface or underground. Drill pattern is adjusted to fit the system, often with substantial savings in drilling and dynamite.

Write for free ROCKMASTER "16" booklet which includes diagrams for typical loadings. And remember that our technicians will be glad to assist you in applying ROCKMASTER to your operations.

ROCKMASTER: Reg. U. S. Pat. Off.

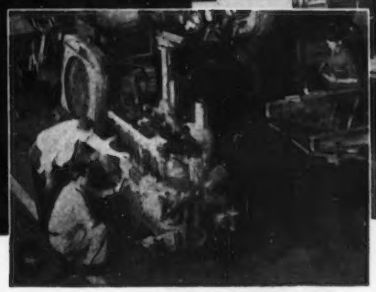
ATLAS EXPLOSIVES
"Everything for Blasting"

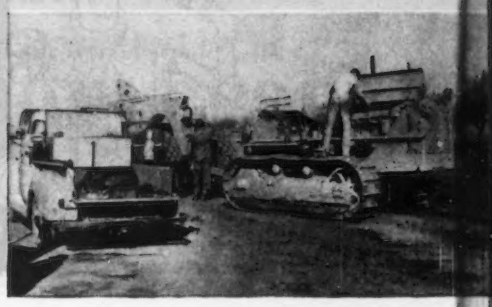
CHEMICALS ATLAS EXPLOSIVES

ATLAS POWDER COMPANY, Wilmington, Del. • *Offices in principal cities* • *Cable Address—Atpowco*

Your strong right arm...

in time of need





BECAUSE of the vast defense mobilization program, material shortages and extra production demands have gripped the nation. They affect particularly the heavy industries and the distributors and users of their products. And huge as America's facilities have become in recent years, they still are not large enough to keep pace with both military and civilian needs.

Nevertheless, as an owner of "Caterpillar" products, you are among the more fortunate. Your "Cat" equipment has been built for long life and to withstand severe working conditions. What's more, it is backed by a dealer organization that is world-famous for experience, accessibility, mechanical facilities and field service to keep you going "come hell or high water."

Since World War II, the already large number of "Caterpillar" sales-and-service establishments has increased greatly. Also since that time, "Caterpillar" and its dealers have developed new techniques for restoring and extending the life of "Caterpillar" products. Today, in their own shops, "Caterpillar" dealers can *rebuild* a great many worn or damaged parts which formerly required completely new replacement. In short, every dealer is richly acquainted with scores of modern ways and means for keeping your machines in good working condition. You can help by doing this:

Take your maintenance problems to your "Caterpillar" dealer* BEFORE *parts are worn beyond repair

Remember that excessively worn parts can cause damage to mating parts; that track parts, pistons and liners, crankshafts, cylinder heads, radiators and other items usually can be salvaged. Your problems are your dealer's problems. Go see him today. He'll do everything in his power to keep your machines operating. Your combined efforts will be reflected in longer equipment life.

CATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS

CATERPILLAR

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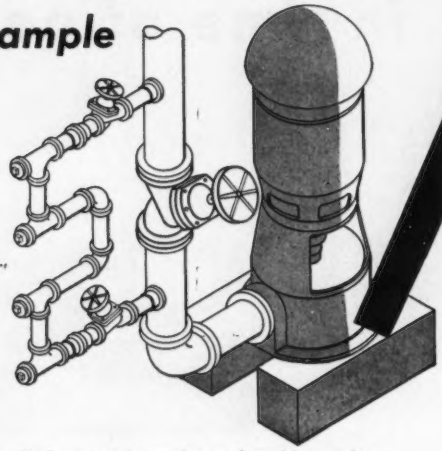
DIESEL ENGINES
TRACTORS
MOTOR GRADERS
EARTHMOVING EQUIPMENT

for outstanding service

on Corrosive Well Water

...for example



The Installation—
Barr Rubber Products Co.,
Sandusky, Ohio

PROBLEM: To eliminate costly seating and packing maintenance, and frequent replacement of valves on plant well-water pump. Valves previously used highly unsatisfactory, having maximum life of 6 months.

WORKING CONDITIONS: Sulphur content of water extremely high. Valve constantly exposed to severe corrosive and erosive effects. Operated infrequently; yet easy operation, positive seating are prime requisites.

SOLUTION TO PROBLEM: Crane Packless Iron Body Diaphragm Valves featuring separate disc and diaphragm design. Three-inch No. 1611 flanged end valve on main discharge; ¾-inch No. 1610 screwed end valves on by-pass.

RESULT: While other valves lasted only 6 months or less, Crane Diaphragm Valves show no effects of service, after more than a year. They operate smoothly . . . seat tightly . . . no maintenance whatsoever needed to date!

Another typical demonstration of superior quality, and the low-cost performance of Crane Valves. That's why . . . More CRANE VALVES are used than any other make!

...Choose Dependable CRANE VALVES

No. 1611 Crane Iron Body Diaphragm Valve —one of a full line suited for many services. Literature on request from your Crane Branch or Crane Wholesaler.

CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
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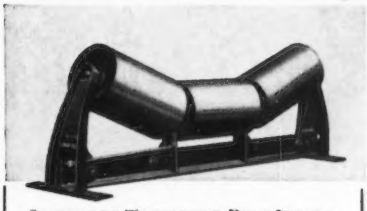
VALVES • FITTINGS • PIPE • PLUMBING • HEATING

LINK-BELT engineering experience...

Link-Belt belt conveyor system with 100-foot radius traveling stacker and 500-foot trailing section, for stockpiling minus 1½-inch washed iron ore at 400 tons per hour.

Belt conveyor collecting ore concentrate from rotary table feeders.

Plus LINK-BELT quality components...



SERIES 100 TROUGHED BELT IDLERS. Strong, balanced integral rolls revolve on high-grade roller bearings, Grease-in, dirt-out seal, large reservoir preserve lubricant.

RUBBER-TREAD IMPACT IDLER for loading points protects the belt by absorbing the shock of heavy materials or lumps delivered from above.

BELT-TRAINING IDLER for automatic belt positioning. The actuating rolls respond to slightest contact — quickly recede and center the belt to minimize wear.

...add up to your best bet in

BELT CONVEYORS

WHAT'S your materials handling problem? Tonnage, distance or a combination of the two? Heavy or light materials? Large lumps or fines? Continuous or intermittent operation?

Whatever the conditions, you'll find the right answers at Link-Belt. For Link-Belt designs conveyor systems to meet your requirements. Backed by unmatched materials handling and power transmission experience, our conveyor specialists help you and your consultants get the right equipment in the right place.

One Source—One Responsibility

Link-Belt makes all the various elements—all types and sizes of idlers, takeups, pulleys, trippers, bearings and power transmission drives. Plus all related equipment—other types of conveyors, feeders, elevators, car dumpers and shakers.

And Link-Belt will build your supporting structures and enclosures . . . install the job completely. One source — one responsibility. Every detail receives the proper attention to assure you an efficient, trouble-free, long-life conveying system.

The next time you need belt conveyor engineering assistance, call the Link-Belt specialist in our office near you.

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 12.360-A

For the Optimum Recovery of these Strategic Minerals

- ★ ANTIMONY
- ★ CHROMITE
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- ★ DIAMONDS
- ★ FLUORSPAR
- ★ MANGANESE
- ★ MOLYBDENUM
- ★ SULPHUR
- ★ TIN
- ★ TUNGSTEN

Strategic Minerals
Government Launches
$500 Million Program
To Up U. S. Output

Tripled Tungsten Production,
Twice[illegible] Much Antimony
A[illegible]ong the Goals

Timely and Helpful Beneficiation Data Compiled by the Cyanamid Mineral Dressing Laboratory

Essential to the success of the [illegible]or increasing the output of strategic minerals is the development [illegible]e concentration methods. No prospect can be realistically evaluat[illegible]milling costs are known. For known but unworked deposits, efficien[illegible]ciation is frequently the key to prompt and successful commercial dev[illegible]ent. In fact, profitable metallurgical processes are the foundation u[illegible]h all plans to expand strategic mineral production ultimately depend.

As our constructive c[illegible]bution to cu[illegible] many metallic and non-metallic minerals, Cyanam[illegible] current practice and avenues of approach to the beneficiat[illegible] needed minerals. In conjunction with other available published data o[illegible] Cyanamid Mineral Dressing Laboratory, these special technical bulletins represent practical guideposts to progress in solving the mineral dressing problems of the expansion program. They are offered, without cost or obligation, as a preliminary to confidential discussion of your particular problems with Cyanamid Field Engineers.

Printed in U.S.A.

In our work with mining companies throughout the world for over thirty years, we have investigated the treatment of many thousands of ore-samples by cyanidation, flotation, Heavy-Media Separation and the Dutch State Mines Cyclone Separator Processes. We have developed many widely-used chemical reagents as well as many special reagents of great value for specific applications. We have pioneered the successful application of advanced processes for Separation by Specific Gravity Differences to a long list of metallics and non-metallics. In our work with mill metallurgists, we have frequently helped to develop special methods for treating ores and waste products hitherto considered too low-grade to be workable. This vast fund of technical data and mineral dressing experience is available to new mines and old through Cyanamid Field Engineers, as a part of Cyanamid Service to Metallurgy.

AMERICAN Cyanamid COMPANY

MINERAL DRESSING DIVISION

30 ROCKEFELLER PLAZA NEW YORK 20, NEW YORK

Mineral Dressing Division
AMERICAN CYANAMID COMPANY
30 Rockefeller Plaza, New York 20, New York

Please send me your special Technical Bulletins on current practice and avenues of approach to the economic treatment of:

☐ ANTIMONY ☐ CHROMITE ☐ COBALT ☐ DIAMONDS
☐ FLUORSPAR ☐ MANGANESE ☐ MOLYBDENUM ☐ SULPHUR
☐ TIN ☐ TUNGSTEN

Also send available technical data on the treatment of

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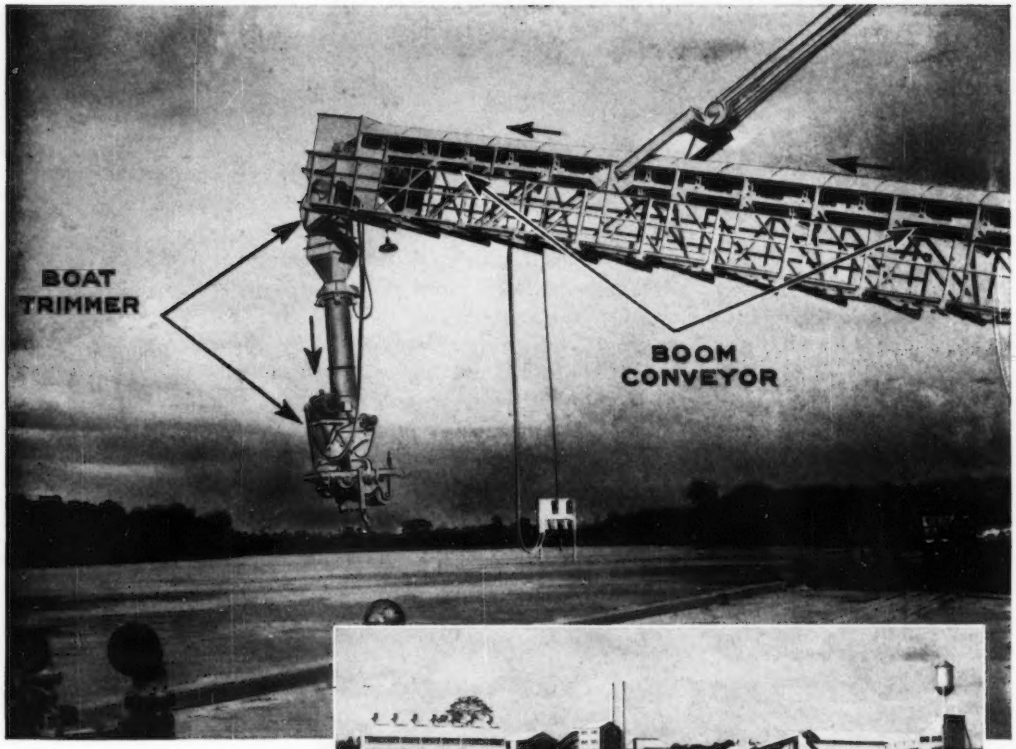

S-A Dockside Conveying Equipment

SPEEDS UP SAILING SCHEDULES

Ore boats now make a faster turn-around when picking up processed bauxite at ore deposits in Surinam, Dutch Guiana. S-A engineers provided a complete handling system for greatest speed and efficiency, maximum tonnage and lowest handling cost per ton. Ore is put through preliminary processing and loaded on to ships rapidly —with maximum use of cargo space—at a definite saving in port time per ship.

Because Stephens-Adamson makes all types of bulk material handling equipment, the S-A engineer is free to recommend the best unit for any specific need. S-A engineers are able to draw on 50 years experience in answering many and diversified conveying and bulk materials problems. They have a complete line of equipment to plan with. It pays to consult the S-A engineer. Write today for all details—no obligation!

ALUMINUM COMPANY OF AMERICA
Surinam, Dutch Guiana, S. A.

S-A Belt and Pan Conveyors move ore through crushing, washing and kiln stages. Storage and reclaiming operations are also handled by S-A Belt Conveyors and travelling trippers. Loading ore into a ship's hold is handled by an S-A boom type belt conveyor. An S-A Centrifugal Boat Trimmer unit, fitted to the spout on a swivel connection, throws material in a stream to the far corners of the hold for maximum use of cargo space.

1901-1951
50 years experience with bulk handling
STEPHEN S-A ADAMSON MFG. CO.
4 Ridgeway Avenue, Aurora, Illinois — Los Angeles, Calif. • Belleville, Ontario

DESIGNERS AND MANUFACTURERS OF ALL TYPES OF BULK MATERIALS HANDLING EQUIPMENT

DESIGNED and DEVELOPED with an ear to the ground!

For the remarkable working efficiency of

MANCHA'S LITTLE TRAMMER,

mine personnel deserves much of the credit. Throughout the years, Mancha engineers have kept their ears to the ground, listening to mining men whose suggestions helped improve and perfect this powerful little locomotive. The *simple construction* and *trouble-free operation* of Mancha's Little Trammer today represent the pooled experience of mining men who contributed ideas to make the Little Trammer ever better.

By *keeping* their ears to the ground, Mancha engineers incorporated in the Little Trammer such mine-proved features as these:

- Simplified design; easy operation; easy accessibility.
- Simple, one-piece welded main frame.
- Powerful single motor.
- Track gauge (18"-30") easily changed *at the mine*.
- Adjustable brake; trouble-free controller.
- Fittings to permit a 3-minute battery change — without manual labor.

Anyone can operate it. Motormen say they're EASY TO RUN.
Repairmen say they're a CINCH TO KEEP RUNNING. Just ask the men who maintain them.

PLANNING FUTURE DEVELOPMENTS?

Mancha's world-wide experience in the application of storage battery locomotives in all types of mines, can prove invaluable to you. Write us about your problems (there's no obligation), and mail the coupon for complete information about Mancha's Little Trammer.

Mancha Storage Battery Locomotive, U.S.A.
Division GOODMAN Manufacturing Company
4850 South Halsted Street, Chicago 9, Illinois
E&MJ — 751

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MANCHA STORAGE BATTERY LOCOMOTIVE

Division GOODMAN Manufacturing Company

4850 SOUTH HALSTED STREET CHICAGO 9, ILL., U. S. A.

HEADED FOR THE

"firing line"

Traylor

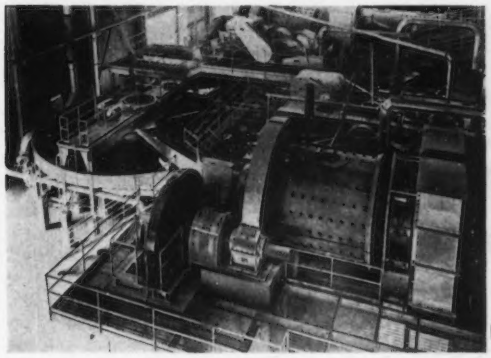
Rotary Kilns, Coolers and Dryers
Grinding Mills . Crushing Rolls
Jaw, Reduction and Gyratory Crushers
Apron and Grizzley Feeders

Traylor Mining Machinery is already headed for the "firing line" in the new battle of production. Profitable operation in the times ahead will demand the use of more efficient . . . *more dependable* . . . machinery. Machinery capable of 24 hour production without staggering manhours of maintenance will become absolutely essential as costs rise and manpower becomes scarce. Traylor Machinery has proved its staying power through 2 world wars. A recent order for 9' 6" x 250' Rotary Kilns from an old Traylor customer . . . one of the country's largest aluminum producers . . . is evidence of the worth of Traylor Machinery in times of emergency. Traylor engineers will welcome the chance to discuss your production problems . . . to show you how Traylor Machinery delivers the goods . . . *at a profit.*

TRAYLOR ENGINEERING AND MANUFACTURING CO.
364 Mill Street, Allentown, Pa.
Sales Offices: New York, Chicago, Los Angeles
Canadian Mfrs: Canadian Vickers, Ltd., Montreal, P.Q.

a 10'0" x 300'0" Traylor Rotary Kiln leaves for the production front

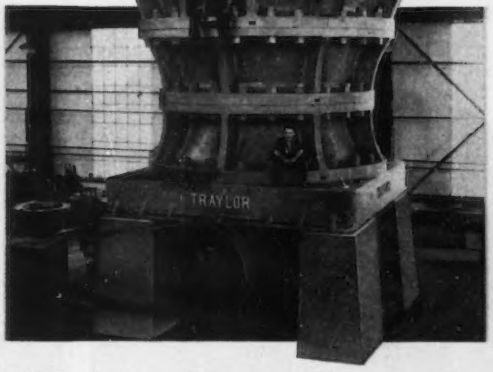
TRAYLOR is building 10 mills of various types, ranging in size from 6′ x 10′ up to 7′ x 40′, to help increase aluminum production. Traylor Grinding Mills boast of many features that account for economies in power requirements, lower maintenance costs and improved product quality . . . features that *you* need to produce *more . . . at a profit.*



THIS AISLE of 15 Traylor Pierce-Smith type Copper Converters has already entered the fight for increased copper production. Traylor recently shipped similar converters to South America to boost our supply of copper from Chile.

Traylor Machinery Means More Copper . . . More Aluminum . . . and Other Essential Metals

ONE 42′0″ and two 34′0″ circular casting wheels are being built for large South American and South African copper producers. Traylor casting wheels are heavily proportioned, driven by two motors through separate gear trains, but with a single control.



A HUGE 60″ Traylor TC Gyratory Crusher erected prior to shipment to one of the worlds leading copper mining companies. A similar crusher is now being built for export to Chile. Traylor Gyratory Crushers produce enormous tonnages at an extremely low power-per-ton ratio.

SEND FOR OUR LATEST CATALOG

It contains complete information and specifications on all Traylor Mining Machinery. Sign the coupon at right.

Traylor
Mining and Milling Machinery

RUSH Traylor Bulletin 6120 to

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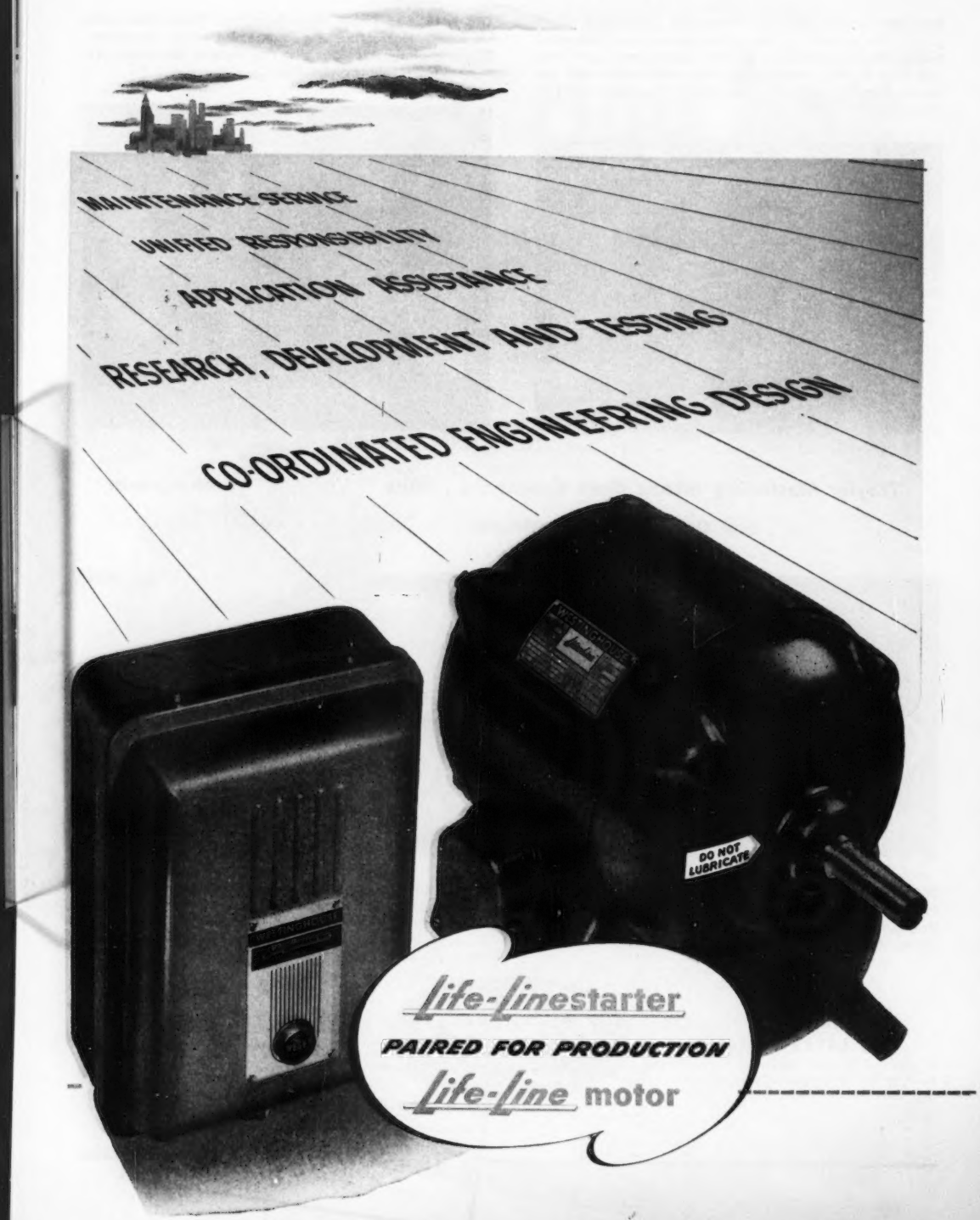
MAINTENANCE SERVICE
UNIFIED RESPONSIBILITY
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RESEARCH, DEVELOPMENT AND TESTING
CO-ORDINATED ENGINEERING DESIGN
DO NOT LUBRICATE
Life-Linestarter
PAIRED FOR PRODUCTION
Life-Line motor

EXTRAS like these assure long-range performance

You get more than a motor and a starter when you install these Life-Lines. You get complete design, engineering and service every step of the way.

CO-ORDINATED ENGINEERING DESIGN makes sure that Life-Line motors and Life-Linestarters give long-range performance. They're made together to work together.

RESEARCH, DEVELOPMENT AND TESTING in Westinghouse laboratories result in such features as:

Steel frame
Pre-lubricated bearings... in Life-Line motors
"De-ion"* arc quenchers
Bimetallic relays . . . in Life-Linestarters*

APPLICATION ASSISTANCE to help you select the right motor and control.

Application engineers for your daily problems
Consulting engineers for special design problems
Field offices in 123 locations for all your service requirements

All at your service without obligation.

UNIFIED RESPONSIBILITY . . . for operation of the motors and protective controls.

One supplier . . . makes your work simpler.

MAINTENANCE SERVICE is all-inclusive and nationwide.

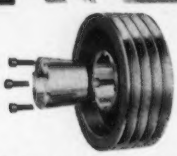
36 fully-equipped repair shops
52 engineering and service offices

Who else can offer all these EXTRAS?

More details? Ask your Westinghouse representative. Call him today. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21637

YOU CAN BE SURE.. IF IT'S
Westinghouse
Life-Line
MOTORS and CONTROLS

IF IT'S DODGE -IT'S DEPENDABLE!

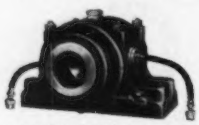


TAPER-LOCK SHEAVES: Patented. Taper-Lock is the world's simplest mechanism for mounting wheels to shafts. Easy on—easy off! 476 stock sizes in A, B, C and D grooves.

TORQUE-ARM SPEED REDUCERS: America's most complete line of shaft mounted speed reducers. Capacities from 1 to 27 h.p. Output speeds from 12 to 330 r.p.m.

DODGE-TIMKEN BEARINGS: Mounted units, proved in millions of industry's toughest jobs. The famous 30,000-hour line. Four types to choose from. Sizes from 1-3/16" to 8".

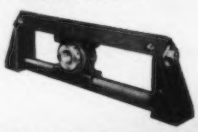
ROLLING GRIP FRICTION CLUTCHES: No toggles! Compact, flexible, smooth and DEPENDABLE. Bolted plate and gear tooth plate. 1.3 to 21.2 h.p. at 100 r.p.m.



SLEEVOIL BEARINGS: Precision built, exceptionally quiet, thoroughly dependable. "Tops" for fan and blower service. Sizes 1-7/16" to 8" in both plain and water cooled types.

SOLID STEEL CONVEYOR PULLEYS: Maximum strength, minimum weight. *Modern* pulleys with interchangeable hubs that cut installation cost. Diameters 6" to 6'. All face widths.

DODGE SEALED-LIFE V-BELTS: Special protection for tension members insures longer belt life. Perfectly matched to Taper-Lock sheaves for best performance.



DODGE TAKE-UPS: Modern, rugged, dependable. Roller bearing (illustrated), ball bearing and babbitted. Shaft sizes from 3/4" to 4". Travel from 4" to 36".

SPECIALISTS IN POWER TRANSMISSION MACHINERY FOR 73 YEARS

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NOTED THROUGHOUT THE WORLD FOR HIGH QUALITY, PRECISION MANUFACTURE

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MANUFACTURERS OF A BROAD LINE OF MECHANICAL POWER TRANSMISSION MACHINERY

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ORIGINATORS OF NEW AND BETTER PRODUCTS FOR THE MECHANICAL TRANSMISSION OF POWER

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USED CONFIDENTLY WHERE THE GOING IS TOUGHEST

DODGE MANUFACTURING CORPORATION, 3100 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER: Most Dodge products are normally available from distributors' stocks — in your territory — when you need them. For information on the newest and best methods of mechanical power transmission, call the Dodge Transmissioneer, graduate of the Dodge factory course. He is your local Dodge Distributor. Look for his name under "Power Transmission Equipment" in your local classified telephone directory.

PILLOW BLOCKS: Roller Bearing, Ball Bearing, Babbitted. **FLANGE BEARINGS:** Roller, Ball, Babbitted. **HANGER BEARINGS:** Roller, Ball, Babbitted. **TAKE-UPS:** Roller Bearing, Ball Bearing, Babbitted. **BASE PLATES. FLOOR STANDS. DROP HANGERS. V-BELT SHEAVES:** Both TAPER-LOCK and Bored-to-Shaft-Size. **BELTS:** Industrial and FHP V-Belts and Flex-Link Belting. **SPEED REDUCERS:** TORQUE-ARM Shaft Mounted Speed Reducers. **CLUTCHES, FRICTION:** Rolling Grip, Diamond D and Solid Types. **COUPLINGS:** TAPER-LOCK Flexible, TAPER-LOCK Rigid and Flange Types. **SAFETY SET COLLARS. PULLEYS:** Steel Split Transmission and Solid Steel Conveyor Pulleys. Rubber Lagging. **VISES:** SLIDE-SET Machinist's...FOR COMPLETE LINE, TYPES AND SIZES, WRITE FOR BULLETINS AND 224-PAGE CATALOG.

DODGE

of Mishawaka, Ind.

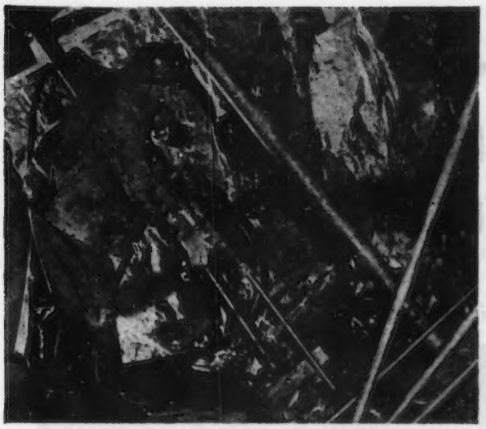
"First in Power Transmission Machinery!"

For exploratory drilling from the surface. Operating at the continuous high speed made possible by bortz bits, the CP No. 15HD DIAMOND CORE DRILL gives exceptional performance with remarkably low maintenance. With E-EX fittings it has a capacity of 2250 feet. The CP No. 8HD has a capacity of 1250 feet.

FROM EXPLORATION TO PRODUCTION

there's a CP drill

For maximum service from tungsten-carbide bits. The medium-weight, fast-hitting CP-34 STOPER and CP-50N DRIFTER are ideal for securing maximum footage from tungsten-carbide bits, because rotation, drilling speed and foot-pound blow are so balanced that excessive machine vibration is eliminated and long bit life assured.



For underground prospecting or blast hole drilling. With the fastest, most powerful rotary motor ever built into a diamond drill, the CP-55 DIAMOND DRILL is equally efficient for coring and blast hole operations.

For faster tunnel driving. Designed for maximum drilling speed and efficiency, the rail-mounted G-600 AIR ACTUATED DRILL JUMBO is furnished in single and multi-boom units. Rail mounted, for standard track gauges.

for every job

For general utility drilling. The CP-32 SINKER DRILL, in the 45-pound class, is designed for all-around service in medium to hard formations.

Write for detailed information

For shaft sinking and underhand stoping. The CP-59 SINKER outperforms any other drill in the 55-pound class, because of its exceptional drilling speed, strong rotation, powerful air blow, and excellent riding qualities.

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On the *TOUGH* Jobs Operators know

JALLOY HEAT-TREATED PLATES

J&L STEEL

. . . resist impact, abrasion and corrosion

. . . provide longer service life, lower maintenance costs

Cost-conscious mine operators throughout the industry are cutting maintenance and downtime costs by installing tough J&L Jalloy heat-treated steel plates on their equipment.

They've found that on the tough applications heat-treated Jalloy lasts 4 to 20 times longer than mild steel. The reason—Jalloy has the physical properties to resist the severe impact, abrasion and corrosion of mining operations. It is produced with a yield strength of 160,000 lbs. per sq. in. and a Brinell hardness of 341 to 388. The result—Jalloy saves money by cutting steel requirements, reducing downtime for repairs and replacement, and keeping labor costs for maintenance to a minimum.

Here are some of the applications where mine operators are using heat-treated Jalloy—Dump Truck Bottom Liners, Coal, Rock and Ore Chute Liners, Dipper Stick, Shovel and Drag Bucket Reinforcing. You can get Jalloy in bar form and in plates up to 72" wide and 20' long with thicknesses from $\frac{3}{16}$" to $1\frac{1}{2}$".

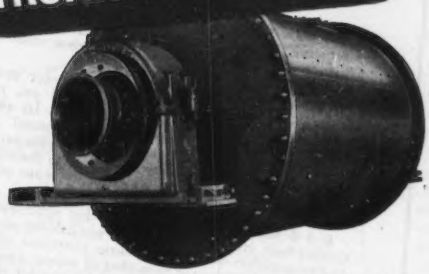
Start finding out more about Jalloy today. Just write to Jones & Laughlin Steel Corporation, 412 Jones & Laughlin Building, Pittsburgh 30, Pa. We'll send you a free copy of our booklet, "For Longer Wear . . . Less Repair!" It will give you more complete information on the properties, heat treating and workability of heat-treated Jalloy, the modern mining and quarrying steel.

JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH 30, PA.

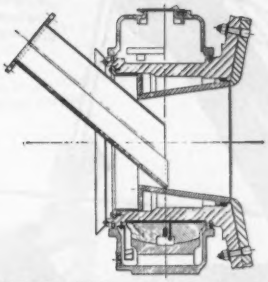
Engineered for *Grinding Mills*

TRUNNION BEARING



EXTRA LARGE — Diameter of king-size Allis-Chalmers trunnion bearing is almost twice the bearing length, large enough to permit spout feeding. Large bearing proportions will provide long service despite heavy-going demands on mill. Internal oil system can be checked visually by means of hinged flap on bearing housing.

LOW BEARING PRESSURE — A spherical seat keeps mill in perfect alignment with bearings. Load is distributed evenly across full face of bearing, reducing wear. Cooling coils embedded in babbitted bearing cool the oil at point where most heat is generated. Piston ring seals hold oil in and dirt out . . . oil supply is always clean.



LONG BEARING LIFE — Internal oiling buckets carry lubricant to oiling pan. Oil is supplied the instant mill is started. All large bearings are fitted with lubricant pump for floating the mill during starting. This overcomes high starting torques and eliminates "dry" starting after shut-downs, which causes about 75 percent of bearing wear.

During normal operation, a film of lubricant separates trunnion from bearing. No metal to metal contact.

After a short shut-down period the thickness of this protecting film of lubricant is reduced.

After long shut-down, lubricant film is broken entirely. The result is damaging metal to metal contact between trunnion and bearing.

Lubricant pump floats the mill before starting . . . re-establishes protecting film of oil. Power needed for starting is greatly reduced, too.

Additional facts about trunnion bearings and other modern features of Allis-Chalmers grinding mills may be obtained without obligation from the A-C representative in your area or by writing to: Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3348

Texrope is an Allis-Chalmers trademark.

Trunnion bearings are built by Allis-Chalmers in 10 sizes from 14 x 8 to 54 x 22-in. The six smallest sizes are available as grease lubricated bearings; seven largest sizes as oil lubricated bearings.

ALLIS-CHALMERS

Sales Offices in Principal Cities in the U. S. A. Distributors Throughout the World.

Motors

Controls

Texrope Drives

Vibrating Screens

Crushers

Kilns, Coolers, Dryers

If you want peak production

U·S·S COR-TEN

U·S·S COR-TEN is a ductile, low-carbon chromium-nickel-silicon-copper-phosphorus steel having a minimum yield point, in thickness of ½" and under, of 50,000 psi—at least one and one-half times that of structural carbon steel.

It has a minimum tensile strength of 70,000 psi in these same thicknesses. Its resistance to abrasion, shock and impact is superior to structural carbon steel; its fatigue resistance — that is, its ability to withstand vibration stresses, is 60% greater.

What particularly distinguishes **U·S·S COR-TEN** is its unusually high resistance to atmospheric corrosion—4 to 6 times that of plain steel, 2 to 3 times that of copper steel. It is this property that helps to assure the safety, long life and low maintenance cost of any equipment in which **COR-TEN** is used to obtain greater durability, or in lighter thicknesses to reduce weight.

U·S·S COR-TEN is produced in all standard products — plates, shapes, bars, sheets, strip, special cold formed sections, wire and tubular products. It is recommended particularly in light and intermediate thicknesses.

U·S·S MAN-TEN

U·S·S MAN-TEN is a grade of manganese-copper steel possessing formability, toughness and weldability in a higher degree than obtainable in carbon steel of the same strength level.

U·S·S MAN-TEN has the high yield point and high tensile strength of 50,000 psi and 75,000 psi, respectively, in thicknesses up to ½" inclusive. Its abrasion resistance is greater than that of structural carbon steel (ASTM A7); its fatigue strength is approximately 40% higher, insuring greater resistance to the vibration and reversal of stresses to which many types of equipment are subjected.

U·S·S MAN-TEN is well suited for applications requiring high strength, toughness, workability and weldability together with atmospheric corrosion resistance equal or slightly better than that of copper steel. More than 16 years of satisfactory service under the most severe conditions have established the suitability of this grade for lightweight, rugged construction.

U·S·S MAN-TEN is produced in plates, shapes, bars, sheets, strip, special cold formed sections and other products. It is particularly recommended for light and intermediate thicknesses.

from your equipment

Give it the stamina to stay on the job

U·S·S TRI-TEN

This manganese-nickel-copper steel has a yield point of 50,000 psi min. and a tensile strength of 70,000 psi min. in thicknesses ½" and under, with moderately lower values as thickness increases to a maximum of 4". It has superior toughness and ability to withstand shock at sub-zero temperatures. It has greater resistance to abrasion than structural carbon steel (ASTM A7) and its fatigue resistance is 50% higher. U·S·S TRI-TEN'S resistance to atmospheric corrosion is slightly superior to copper steel.

Because U·S·S TRI-TEN has very good welding properties in intermediate and heavier thicknesses, this grade is particularly recommended for application in heavy duty equipment, such as illustrated below, where maximum ruggedness and strength with minimum weight are prime requisites.

U·S·S TRI-TEN is produced in plates, structural shapes, bars and bar shapes.

YOU can do it with U·S·S High Strength Steels.

Today the mining industry faces the biggest task in its history. To meet the nation's critical mineral requirements it must produce as never before.

Big-capacity, faster and more powerful equipment will help you meet this situation. But *only* if it is rugged enough to take a record amount of punishment, *only* if it can stand up in any kind of weather—day after day.

That's why it is so important to minimize, as far as possible, structural failures that can put costly, urgently needed equipment out of service. That's why it is vitally necessary to make sure that your drag lines, shovels, crawlers, 'dozers, trucks, mine cars, and other essential equipment are built as strong, as tough and as durable as possible.

You can do it with U·S·S High Strength Steels.

With high-strength U·S·S COR-TEN, U·S·S MAN-TEN and U·S·S TRI-TEN, equipment breakdowns that hamper operations and run up costs can be greatly reduced. With these famous "steels that do more" you can build maximum strength and toughness into vital parts ordinarily prone to failure. With them, high resistance to wear, fatigue, abrasion, atmospheric corrosion and shock can be incorporated where needed.

In addition, these U·S·S High Strength Steels—because they have a yield point 50% higher than ordinary structural steel—can be used to materially increase the strength of parts without increasing their weight. Or they can sometimes be used in lighter sections without in any way diminishing strength or stamina. In both cases, substantial savings in steel may result. This is important now, with steel in restricted supply.

Our engineers for 16 years have cooperated with the mining industry in applying U·S·S High Strength Steels to equipment noted for its dependability, long life and low maintenance cost. They will be glad to show you how these tougher, stronger, more durable steels can be applied to give your equipment the stamina to stay on the job.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND • UNITED STATES STEEL COMPANY, PITTSBURGH
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DENVER SUPER-AGITATOR (PATENTED) AND CONDITIONER

FOR TOUGH PROBLEMS IN

Agitating	Mining
Aerating	Milling
Mixing	Processing
Blending	Chemical
Conditioning	Industrial
Scrubbing	Food
	Foundry

EVERY PARTICLE MIXES

Feed normally enters directly into the standpipe top . . . is sucked down and is positively mixed by the propeller at the lower end. Thus, there can be **no** short circuiting of pulp as every particle is thoroughly agitated and mixed.

FEED LOW...DISCHARGE HIGHER

A feed port is available directly to the lower end of the standpipe. Since discharge is at a higher point, an actual gain in elevation can be had for series applications.

EVERY PARTICLE RECIRCULATES

Pulp movement in the tank is constantly toward the adjustable central standpipe due to the sucking and mixing action of the propeller and the resulting controlled vortex down the standpipe. Intermediate recirculation ports may be opened or closed depending on the treatment process.

NO SANDING UP

For intermittent operation or between shifts, there is no problem of "digging out" as the replaceable alloy iron standpipe flange prevents "sanding in" of the propeller.

SIZES 3' x 3' to 20' x 20'

Write for Deco Bulletin A2-B2, containing detailed information and pulp density charts for calculating size required.

FLOTATION ENGINEERS

DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

"The firm that makes its friends happier, healthier and wealthier"

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DENVER EQUIPMENT COMPANY, 1402 17th St., Denver 17, Colorado

For improved drilling costs

AND

higher man-shift production

. . . use Le Roi-CLEVELAND Air-feed Sinker Drills

THE free world needs a lot of copper, iron, nickel —whatever you mine. So don't let manpower problems curtail your production. Give your miners a helping hand. Equip them with Le Roi-CLEVELAND Air-feed Sinker Drills—and watch the increase in tonnages per man-shift, the improvement in drilling costs.

Here's why miners get more done with Le Roi-CLEVELAND Air-feed Sinker Drills

Setups are faster — our Air-feed Sinkers are much lighter and easier to handle than a drifter drill. When a miner uses one of them with our lightweight Model 83 air column, he can set up in just a few minutes.

Changing steels is quick and easy — the quick reverse feed saves time and all controls are handy. Moreover, a miner doesn't have to loosen or tighten swing or dump nuts.

Drilling speeds are high — the fast, light blows of Le Roi-CLEVELAND Air-feed Sinker Drills are just right for carbide bits. You get maximum bit life — this lets you use smaller bits for higher drilling speeds.

Note — in addition to more footage per shift and more tonnage per man you get these extras: extremely low air consumption — and maintenance costs that are 50% less than those of a drifter.

Le Roi-CLEVELAND Air-feed Sinker Drills are available in two sizes — the HC10R using the popular 45-lb. H10 drill and the HC23R with the 3½-inch bore H23 machine. Write today for complete information.

LE ROI COMPANY

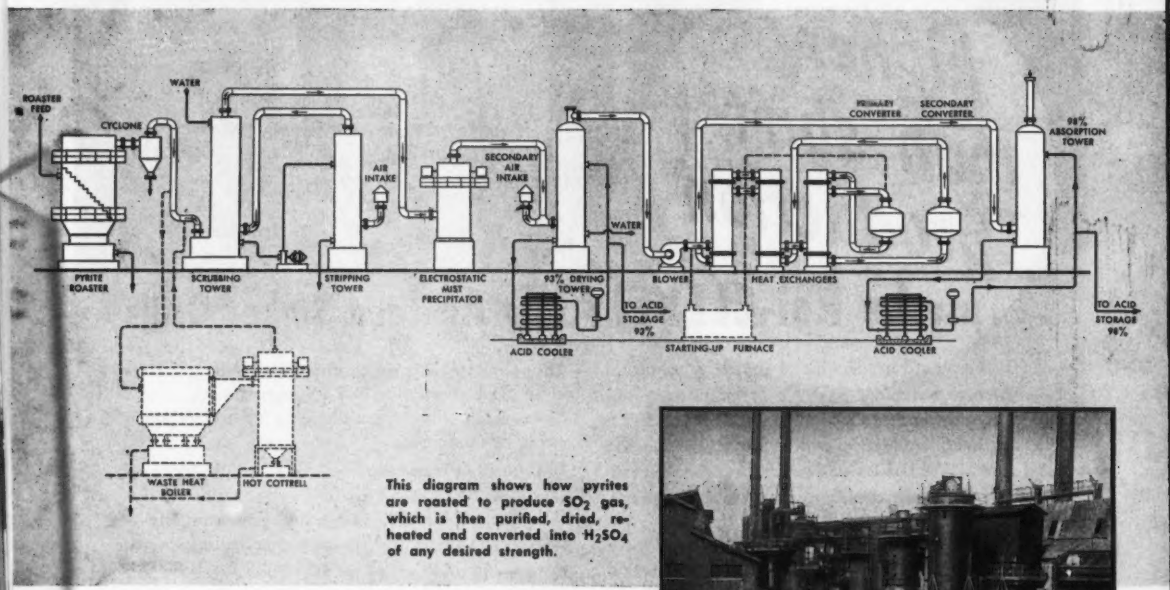
CLEVELAND ROCK DRILL DIVISION

12500 Berea Road, Cleveland 11, Ohio

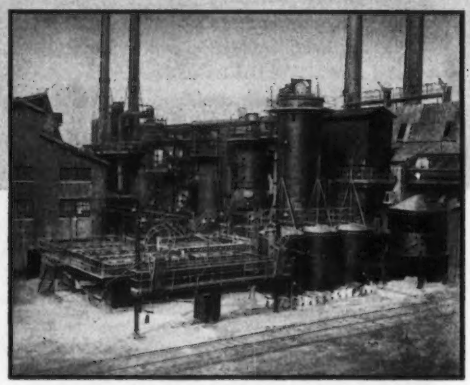
Plants: Milwaukee • Cleveland • Greenwich, Ohio

Another practical solution to the sulfur shortage

Make Sulfuric Acid from PYRITES



This diagram shows how pyrites are roasted to produce SO_2 gas, which is then purified, dried, re-heated and converted into H_2SO_4 of any desired strength.



HERE's a practical answer to the sulfur shortage. With the Chemico acid process diagramed above, vitally needed sulfuric acid can be manufactured from ores such as pyrite, pyrrhotite and other metal sulfides which are in plentiful supply. The Chemico acid process can be adapted to use the sulfur dioxide gas from any preferred standard type of roaster.

Our wide experience in the design and construction of acid-making facilities enables us to deliver efficient plants on a performance-guaranteed basis.

For additional information on this Chemico process write for Bulletin S-102

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND

CABLES: CHEMIGONST, NEW YORK

Chemico plants are profitable investments

WANTED

More production with limited manpower

IT CAN BE DONE!

. . . with faster drilling CARSET JACKBITS

Because they are tipped with Carboloy inserts—one of the hardest metallic substances known to man—Carset Jackbits drill the hardest rock with a *speed* and *efficiency* which cannot be approached by the finest steel bits.

For instance, Carset Jackbits drill 50% faster—last from 50 to 400 times longer—practically eliminate bit changes and double the life of drill steel. They eliminate tapered holes saving up to 30% on dynamite—permit longer steels and feeds—require much less maintenance—and boost tonnage as much as 50% or more.

These advantages all add up to a tremendous increase in footage per shift—*without increasing your drilling crews.* Remember Ingersoll-Rand offers a complete line of equipment and service for rock drilling. Take advantage of our highly trained and skilled personnel. There is an Ingersoll-Rand branch office and distributor near you. Write or call today.

CARSET JACKBIT

SET WITH CARBOLOY INSERTS

Ingersoll-Rand

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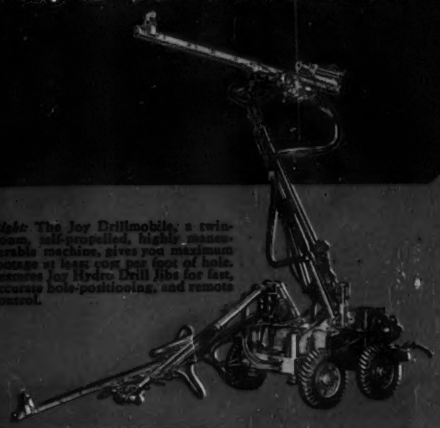
ROCK DRILLS • COMPRESSORS • AIR TOOLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL & GAS ENGINES

UNDERGROUND, OR . . .

IT'S JOY EQUIPMENT



Right: The Joy Drillmobile, a twin-boom, self-propelled, highly maneuverable machine, gives you maximum footage at least cost per foot of hole. Features Joy Hydro Drill Jibs for fast, accurate hole-positioning, and remote control.

Above: For high-production loading and haulage of rock and ore, Joy teams of trackless loaders and electric or diesel shuttle cars get the call underground.

Right: Complete range of Joy Stopers includes the new S-91T, with telescopic feed. Requires fewer steel changes, gives more time for drilling.

Below: Joy Wagon Drill specially adapted to drill at any height from toe-holes to horizontals 9' high.

Left: The Joy HS-15 high speed drill for underground blast holes, or core drilling to 500'. Compact and easy handling, with "in-line" vibrationless drive.

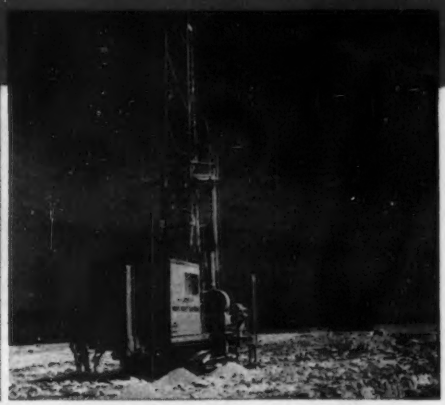
Below: Joy Hydro Drill Jibs are versatile units; can be mounted as required to suit individual needs. This truck-mounted Jib is an example.

. . . ON THE SURFACE

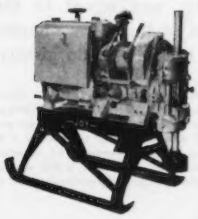
FOR GREATER TONNAGE FOR LOWER COSTS

Above: Joy builds a complete line of "Silver Streak" Hand Tools, cadmium-plated for rust protection and easier running in.

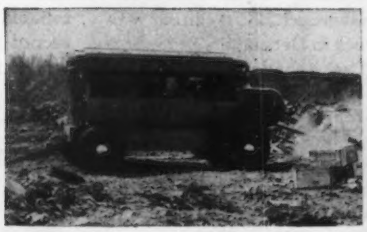
Above: Joy Wagon Drills (Medium and Lightweight models) are easily maneuvered units with positive locking brakes for quick set-ups and balanced drilling on any terrain.



Above: Joy Champion Rotary Drills set absolutely new standards in high-speed, economical blast hole drilling, far outperforming all others. Built in two self-propelled models, for diesel, gasoline engine or electric motor drive.

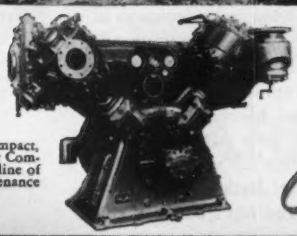


Above: Joy Core Drills range in capacity from 250 to 1750 feet of 1½" hole. Screw feed or hydraulic types—gasoline, diesel, air or electric drive.



Left above: Joy's popular Series 80 Portable Compressors, with the famous "Econo-Miser" load control, are built in seven sizes, from 60 to 630 CFM.

Above: Joy Hydro Drill Jibs are readily adaptable to truck-mounting, etc. for secondary drilling or toe-holes in quarries or open-cut mining.



Right: Joy pioneered the compact, modern "package-type" Air Compressor—offers a complete line of highly efficient, low maintenance airplants up to 3656 CFM.

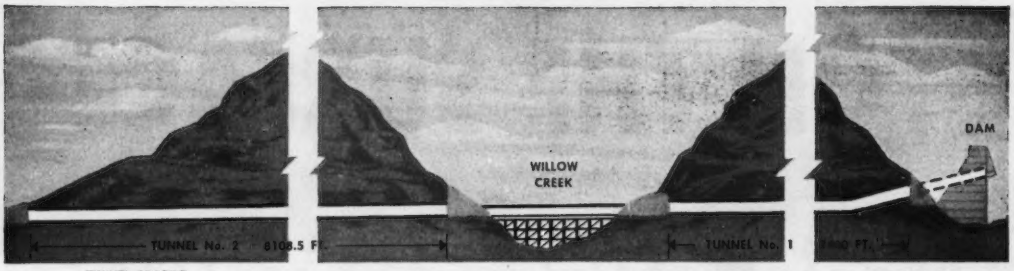
Consult a Joy Engineer

W&D M-3363

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

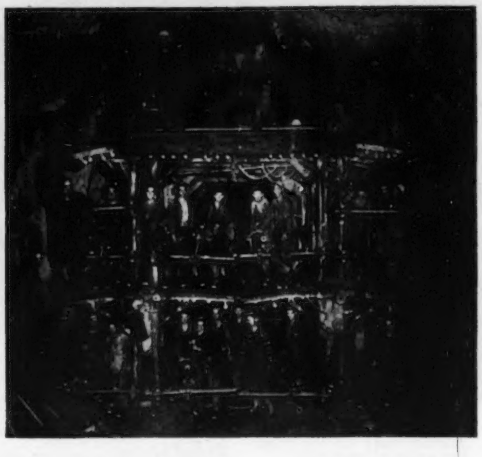
IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO



TUNNEL PROFILE—Water develops a static head of 420 ft, rushing downgrade from the dam (right) through two sections of 24-ft diameter horseshoe tunnel and a 15½-ft diameter steel conduit across Willow Creek (center) on its way towards the powerhouse.

Two mountains tunnelled in record time for Southern California power job

HARD HATS AND BRASS HATS—From left to right: Paul Peecook, So. Calif. Edison Co., engineer; "Scotty" Harris, tunnel foreman; Harry W. Morrison, president of Morrison-Knudsen; Carl J. Herslof, tunnel superintendent; James N. Wells, district manager for M-K; and H. L. Leventon, construction manager.



RECORDS SMASHED—Three-story drill carriage mounts thirteen drifter drills. In the 2400-ft section the crews set a record of 222 ft advance in a 6-day week. This record was twice broken in the 8108-ft tunnel where advances of 227 and 241 ft were achieved.

Bored through granite at a fast pace that smashed three records, two 24-ft diameter power tunnels have been completed at Big Creek Project No. 4 in the foothills of the Sierra Nevadas, about 55 miles northeast of Fresno. Mountain water, dammed and diverted into this tunnel system, will spin generators to the tune of 84,000 kw for this region of zooming growth. Part of Southern California Edison Company's record construction program, this project forges a sixth link in the chain of hydroelectric power plants operated by this utility on the San Joaquin River and Big Creek, a tributary.

The drilling crews established what are believed to be new records for large-diameter tunnels when they advanced 222 ft during a 6-day week in December, 1949. This record was shattered in January, 1950, with 227 ft of advance; and in March, a new figure of 241 ft was chalked up: an average of 40.2 ft per day, working three shifts.

Using 3½-inch drifters and 2-inch carbide insert bits, the contractors pounded in an average of 94 holes of 12-ft depth each round. Used in 4-ft changes, the drill steel was kept in shape by the well-equipped blacksmith shop at the Willow Creek portals. Most of the rods on this job were made up from 1¼-inch Bethlehem Hollow Drill Steel. The top quality of this reliable steel was equal to the record pace of this new chapter written into tunnel-driving history.

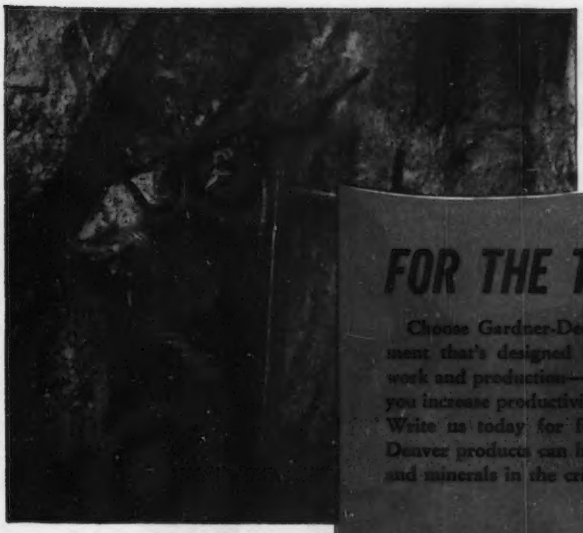
Big Creek Project No. 4 for Southern California Edison Co. is a joint venture of Bechtel Corp. and Morrison-Knudsen Co., Inc., with Bechtel as overall sponsor and M-K as sponsor of dam and tunnel construction. J. R. Kiely of Bechtel Corp. is general manager; H. L. Leventon, construction manager; Carl J. Herslof, tunnel superintendent; John L. Armitage, dam superintendent—all of Morrison-Knudsen.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

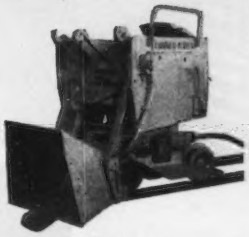
BETHLEHEM HOLLOW DRILL STEEL



FOR THE TOUGH DRIVE AHEAD

Choose Gardner-Denver—and you choose quality mining equipment that's designed by experts to help you speed development work and production—to help you hold down mining costs—to help you increase productivity, even among your less experienced miners. Write us today for further information on how these Gardner-Denver products can help you boost production of essential metals and minerals in the critical days ahead.

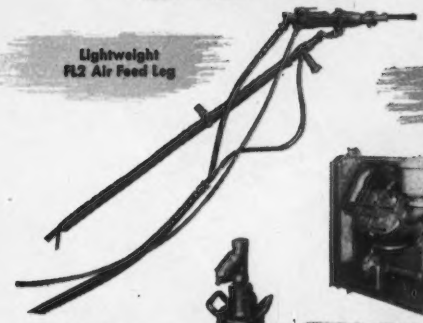
1-, 2- and 3-Boom Hydraulic Jumbos



"Fast-Dipper" Mine Car Loaders

Automatic Water-Control BB Stopers

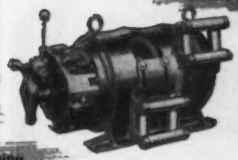
Hard-Hitting Sinkers in every Weight Class



Lightweight FL2 Air Feed Leg

Automatic Drifters and Long Feed Sheils

Compact, Cool-Running WB Compressor



Fast-Acting D56 Sharpener and Former

Top-Suction VP4 Sump Pump

Load-Lugging Airlushers

Automatic LO1? Line Oiler

SINCE 1859

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

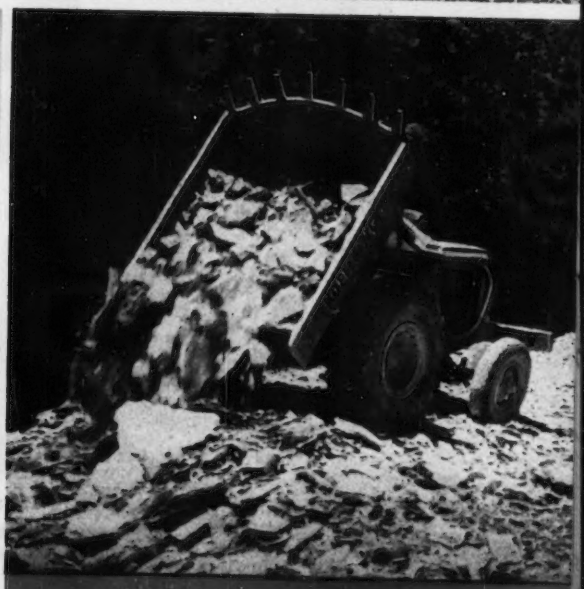
THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

9% MORE OUTPUT with

NO BODY HOIST . . .

Because Dumptor has no body hoist, there are no hoist maintenance delays or costly replacement parts to eat into work-time or profits. Gravity dump is instantaneous even in sub-zero weather; never balks, never wears out.

In addition to 7-second gravity dumping, Koehring Dumptor is fast spotting at the hopper or edge of bank. There's no slow jockeying back and forth. With same speeds forward and reverse, Dumptor drives up, body forward, dumps and heads back without turning.



Fast-cleaning, scoop-shaped body has all-welded sides, ends and bottom heavily-reinforced with 6" channel ribs for rock service. More than triple strength is built into steel-on-steel bottom. Free-swinging kick-out pan adds another steel layer for extra protection.

1-SECOND GRAVITY DUMP

IT takes just one second to dump a full 6-yard load with Koehring heavy-duty Dumptor. Operator trips the body release lever and gravity instantly tilts the scoop-shaped body 70° . . . one second later the body is empty, and Dumptor is on its way back for another load. Because there's no waiting for slow-acting body hoists, Dumptor saves 15 to 25 seconds every dump. This adds up to important gains in yardage output. At 16 trips per hour on a 1,000′ haul, 20 seconds dumping time saved on every cycle gains 5.3 minutes more productive haul-time . . . adds 9% to hourly yardage output.

This is typical of Koehring Dumptor's basic principle . . . to reduce all non-productive time to the absolute minimum . . . and to increase work-time for more yards per hour, more profit per yard *for you*. Dumptor has many other cost-cutting advantages worth checking . . . see your Koehring distributor.

KOEHRING COMPANY, Milwaukee 16, Wis.

K110

KOEHRING DUMPTOR®

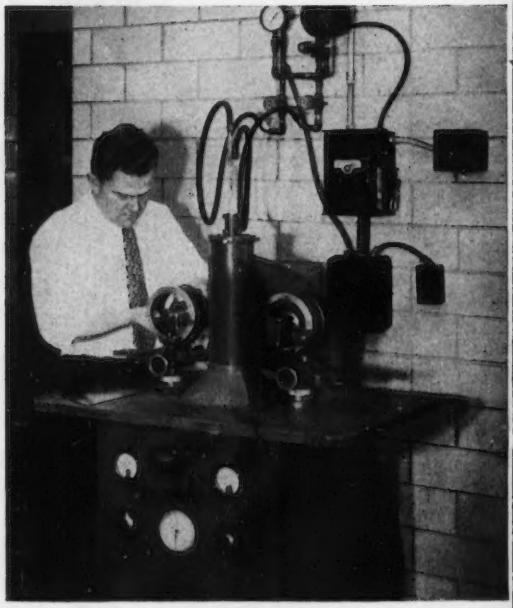
KOEHRING HEAVY DUTY

SUBSIDIARY COMPANIES: [illegible] • JOHNSON • PARSONS

skill experience and manufacturing facilities

these account for the Superior

CHROMEX B—an extremely hard fired chrome-magnesite refractory having unusual constancy of volume and strength at high temperatures.



METALKASE—the pioneer metal encased basic brick possessing an unusual combination of desirable properties.

CHROMEX—a chemically bonded chrome-magnesite brick having excellent spalling resistance.

MAGNEX—a chemically bonded magnesite-chrome brick—highly basic and of low spalling tendency.

H-W MAGNESITE—the standard burned magnesite refractory for more than half a century.

THERMAG—a hard burned magnesite-chrome refractory possessing enhanced physical properties.

H-W CHROME—a hard burned chrome brick especially adapted for various specific uses.

FORSTERITE—the only commercially produced magnesium-silicate brick—suited for certain particular applications.

H-W PERIKLASE—an exceptional high-magnesia brick of unusual high-temperature stability.

Quality of HARBISON-WALKER *basic* REFRACTORIES

Harbison-Walker produces basic refractories especially suited for each particular need in furnaces for smelting ores, refining metals and manufacturing alloys.

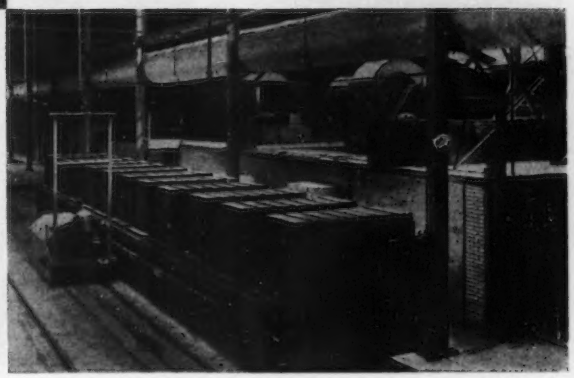
Among the brands listed here are types and classes established as standards for furnaces employed in the metallurgy of copper, nickel, aluminum, lead and various white metals and alloys.

The superior performance of Harbison-Walker basic refractories is the result of: (1) a thorough knowledge of the requirements gained through close cooperation with producers of metals and alloys; (2) extensive and continuous original research conducted by the Harbison-Walker Research Department; and (3) top quality raw materials processed in modern plants under close laboratory control. Harbison-Walker uses the most up-to-date methods and equipment to insure the quality and uniformity of their basic refractories.

(*Above*) This modern brick pressing machine at the new Baltimore, Maryland plant is typical of the most effective equipment used in the manufacture of Harbison-Walker products.

(*Left*) Harbison-Walker research studies of compositions and manufacture of basic refractories and their performance under operating conditions are augmented with X-ray equipment.

(*Right*) The dependable uniformity of Harbison-Walker products is assured by the use of the most accurate instrument-controlled equipment. Tunnel kiln cars leaving dryers for kiln.



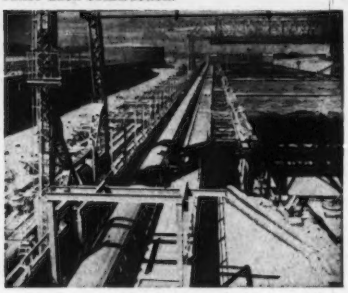
OTHER HARBISON-WALKER BASIC REFRACTORIES

H-W Magnamix
H-W Washington Dead Burned Magnesite Grains
H-W Washington Furnace Magnesite
H-W Special Furnace Chrome
Plastic Thermolith Batch
Thermolith and Other Cements

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
World's Largest Producer of Refractories
GENERAL OFFICES • PITTSBURGH 22, PA.

U. S. Rubber conveyor belt establishes a world's record

This record-breaking "U.S." belt carries a maximum of 5,000 tons of copper ore per hour, travels 600 f.p.m. through a traveling tripper. Total belt length is 2990 feet, width is 60", 42-ounce duck construction.



Twelve years' exposure to blistering tropical sun, one of rubber's worst enemies, has had little or no effect on the belt. It is located at the plant of the Chile Exploration Co., an Anaconda Copper subsidiary.

This U. S. Rubber conveyor belt in operation at a Chilean copper mine has carried over *100,000,000 tons* of abrasive copper ore . . . a world's record . . . at the amazingly low cost of less than *45¢ per 1,000 tons!* The belt has been in continuous service for over 12 years. The operators say there are still many more years of service in the belt, despite this record-breaking performance.

Such success as this results from 3-way engineering teamwork; mine operators, designers of conveyor equipment, and the United States Rubber Company belt engineers. For *your* haulage problem, large or small, call in a "U.S." engineer. Write to address below.

PRODUCT OF

U.S.RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Get maximum safety and service life at minimum cost

WITH JOY ELECTRICAL CONNECTORS

CONVENIENT • FLEXIBLE • ECONOMICAL

RIGHT ... Tap-off made with Joy Connector. Circuit can be opened or closed at will—speedily, safely, neatly—simply by engaging or disengaging male plug.

WRONG ... Photo taken in lead mine shows how extension was wired into main line and later carelessly cut off, thereby creating a hazardous condition.

OVAL STYLES
Also available with 3 contacts

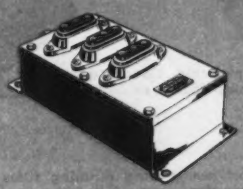
Female Portable

Female Wall Receptacle

Male Machine Receptacle

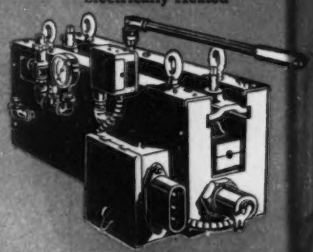
Male Portable

GANGS
#F137 Gang



For power tap-offs from single feeder to a variety of operating equipment. Available in 2, 3, and 4 outlet styles. Input fitting threaded for conduit.

CABLE JACKET VULCANIZERS
Electrically Heated



Electric immersion type heaters generate steam for heating mold. Heat control is fully automatic. Has safety "pop-off" steam valve. Available in five standard sizes.

MOLDS AVAILABLE FOR ALL STANDARD CABLE SIZES

Dangerous, makeshift wiring installations can be eliminated with the use of Joy Electrical Connectors. Of one piece molded Neoprene construction, Joy Connectors are watertight and shatter-proof—impervious to adverse climatic or mining conditions. Oils, acids, alkalies or moisture have little effect on their life span or conducting efficiency.

All Joy Connectors are supplied with lengths of cable as specified by the customer. Each Connector is permanently attached to its cable through "taper-neck" vulcanization—a process that provides additional strength at this vital point. When fully engaged, contacts are completely enclosed in a waterproof Neoprene housing.

For an easy and economical solution to your wiring problems try Joy Electrical Connectors. A wide variety of types and styles is available—each designed for maximum safety, economy, and trouble-free service.

An attractive new Joy Bulletin, No. MC-109, available upon request, describes this equipment in detail.

Write for Bulletins, or *Consult a Joy Engineer*

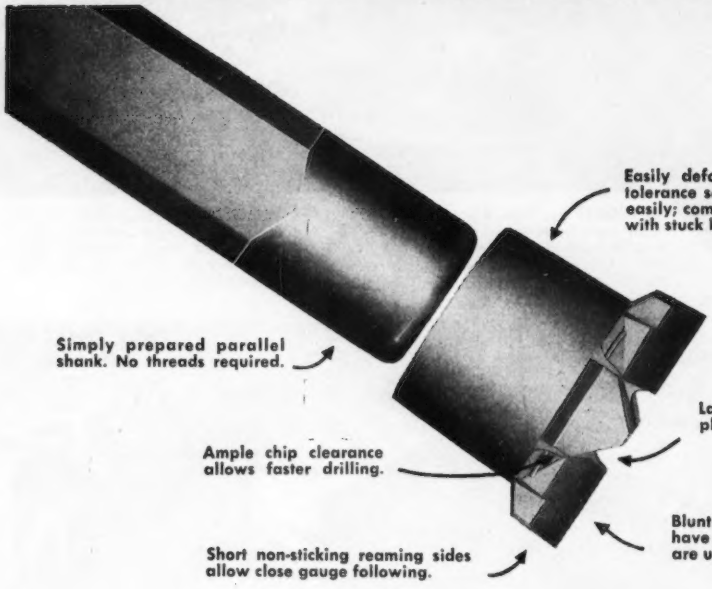
W&D ME 3554

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

THROWAWAY


Easily deformable skirt with close tolerance socket hole . . . bit goes on easily; comes off easily; no lost time with stuck bits.
Simply prepared parallel shank. No threads required.
Large hemispherical non-plugging water outlet.
Ample chip clearance allows faster drilling.
Blunt non-breaking cutting edges have self-sharpening tendency — are uniformly hard.
Short non-sticking reaming sides allow close gauge following.

LOWER YOUR DRILLING COSTS

with

THE "ORIGINAL" ONE-USE BIT

Increased Rod Life with this Strongest and Cheapest Connection

Maximum Footage – Above Average Hardness

Minimum Breakage with Tougher Sockets

Made in All Gauges

THE "TEST" WILL PROVE ITS WORTH

THROWAWAY BIT CORPORATION

4200 N.W. Yeon Ave. **Portland, Oregon, U.S.A.**

Fully descriptive literature on all products is available. Competent field engineers and dealers are always at your service.

Some territories still open for distributors and jobbers.

Here's a Wire Rope That LASTS

J&L STEEL

Operators Get Longer Service Life with . . .

J&L CENTERFIT WIRE ROPE

If you're responsible for the wire rope on clamshells, shovels or any other earthmoving equipment that operates on small diameter sheaves and drums, J&L CenterFit Wire Rope can help you save money.

CenterFit, produced exclusively by Jones & Laughlin Steel Corporation, has a unique design engineered to give you more steel and fewer voids than conventional wire rope. All strands run in the same direction with outside strands fitting snugly into the valleys between inside strands. The result—greater strength . . . easier handling . . . which means longer service life.

In addition J&L CenterFit is lubricated with BRONZ-LUBE, the exclusive J&L lubricant with high film strength that prevents squeezing out between the strands. BRONZ-LUBE contains fine flakes of soft bearing metal that provide a smooth wear-resistant surface for every wire—forms a close adherent coating that doesn't drip off unless subjected to extremely high temperatures.

Users' records prove that J&L CenterFit lubricated with BRONZ-LUBE reduces operating costs, diminishes downtime and increases profits when used in the applications for which it was designed.

AND HERE'S HOW YOU CAN FIND OUT MORE ABOUT CENTERFIT WIRE ROPE!

Just write to Jones & Laughlin Steel Corporation, 412 Jones & Laughlin Building, Pittsburgh 30, Pa., and ask for a free copy of our booklet, "CenterFit." It gives you detailed information on the construction and applications of this exclusive J&L wire rope and tells how others are saving money through its use.

JONES & LAUGHLIN STEEL CORPORATION

From its own raw materials, J&L manufactures a full line of carbon steel products, as well as certain products in OTISCOLOY *and* JALLOY *(hi-tensile steels).*

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS

Walworth manufactures a complete *line* of Gate, Globe, Angle, Check, and Lubricated Plug Valves, made of Stainless Steel, Steel, Iron, Bronze, and Special Alloys in a wide range of sizes and temperature-pressure ratings.

Fittings of steel, iron, and bronze are also manufactured in all conventional types and sizes.

WALWORTH

valves and fittings

60 East 42nd Street, New York 17, N. Y.

Distributors in principal centers throughout the world

It's a Fact!

JOY AXIVANE® MINE BLOWERS

produce more air per horsepower

You don't have to make complicated tests to check the efficiency of Joy blowers. Just compare the performance data listed in Joy Bulletin No. J-607 with the published performance data of conventional mine blowers. That will give you positive proof that the mechanical efficiency of Joy blowers is unexcelled for high or low pressure operations.

Moreover, the pressure range in which AXIVANE blowers operate with unequalled efficiency is so wide that it is totally unnecessary to have one type of blower for short lengths of tubing and another type for longer lengths. The Joy AXIVANE mine blower will operate through any length of tubing with high efficiency.

Five sizes, ranging from ½ to 5 H.P., make up the series. For greater duties, AXIVANE fans from 5 to 3000 H.P. are available.

● *For complete data, write for Bulletin J-607.*

AERODYNAMIC DESIGN

The blades of Joy blowers are of airfoil shape, similar in cross-section to an airplane wing. Rotors are of cast-aluminum construction, permitting accurate adherence to the design shape. Both the number and shape of the blades and stationary vanes are mathematically determined to insure greatest efficiency. The minute clearance between blade-tip and blower casing eliminates most tip loss, a common cause of fan inefficiency and noisy operation.

VANEAXIAL CONSTRUCTION

Joy blowers have stationary vanes to recover the rotative energy imparted to the air by the rotor. The airflow from AXIVANE blowers is therefore substantially axial. The unequalized outlet pressures of all other fan types create non-axial, turbulent airflow, which is wasteful of power. Joy blowers consequently give you a more favorable electric-to-air-power ratio, and are relatively quiet in operation.

Consult a Joy Engineer

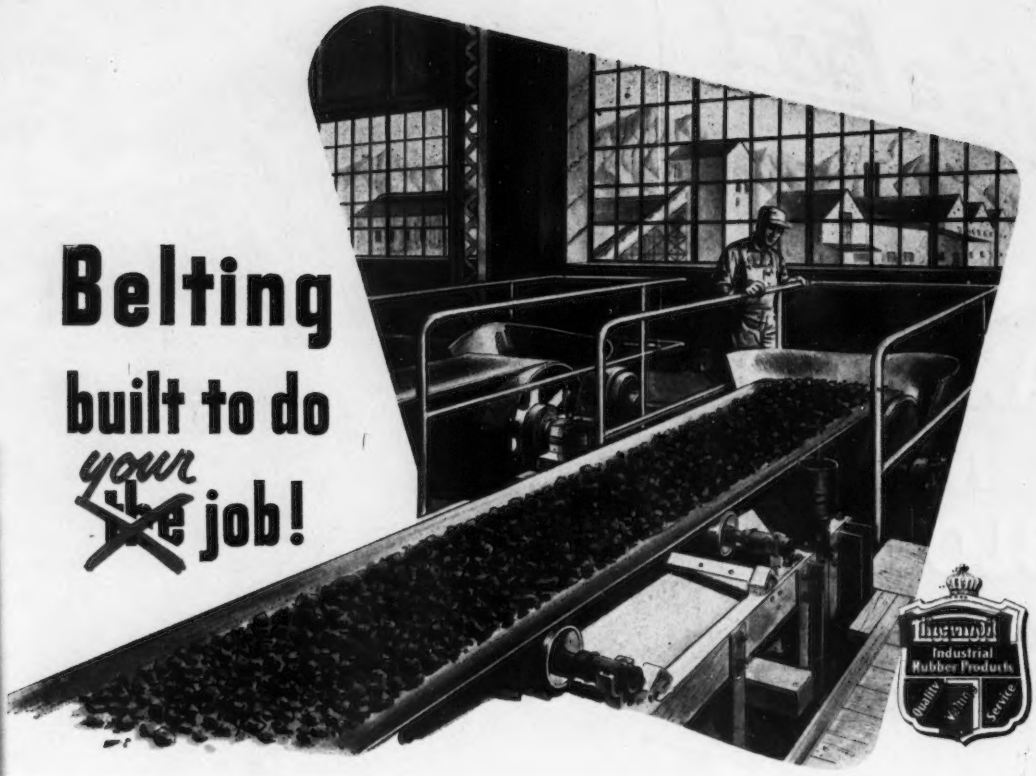
W&D CL 3752

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

Belting built to do ~~the~~ *your* job!



THERMOID tailor-made conveyors promote profitable operation

Toughness measured by long years of industry-wide approval is your basic assurance of satisfaction with ***Thermoid*** Conveyor Belting. Its record of endurance is documented by results that mean greater profits. And equally important — ***Thermoid*** advanced engineering adapts this rugged product to your specified belting requirements, assuring an installation that will do the job . . . YOUR job!

Whether your need is conveyor belting for mining operations, ore concentrating, smelting, refining or dredging — call your ***Thermoid*** distributor. If you have a special problem a ***Thermoid*** Field Representative is always available to help you select the right belt for YOUR job.

Thermoid

Conveyor & Elevator Belting • Transmission Belting • F.H.P. & Multiple V-Belts
Wrapped & Molded Hose • Rubber Sheet Packings • Molded Products
Industrial Brake Linings and Friction Materials

Offices and Factories: Trenton, N. J. Nephi, Utah

For Modern MINES

Thor SINKER LEGS

SENSATION OF THE MINING INDUSTRY

Compact air feed leg clamps to standard Sinker Rock Drill, converts upward lifting action to positive forward feeding pressure. Drills holes at any angle!

Thor PORTABLE POWER TOOLS

and Mining Applications

FOOL-PROOF CONTROLS—Roll-type feed throttle and air bleeder valve button, located side by side, give drill runner complete control of operation at all times.

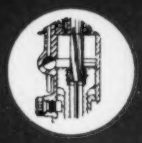
EXCLUSIVE "AROUND THE CYLINDER" CLAMPING. Bayonet connection permits drill and cradle to be removed as unit for use as Sinker or for instantaneous replacement by larger or smaller drills.

PISTON ROD STATIONARY. Model 53, 36" nominal feed travel, weight 38 lbs.

CYLINDER STATIONARY. Model 63, 48" nominal feed travel, weight 50 lbs. Model 64, 38" feed travel, weight 44 lbs.

INDEPENDENT PNEUMATIC TOOL COMPANY • AURORA, ILLINOIS

EXCLUSIVE AUTOMATIC VALVE utilizes ALL the air that enters the machine, measures it for most effective use through machined tolerances of .0005" of an inch. No separate valve parts to lose or wear!



"STRAIGHT LINE" BLOWING — Blower Valve puts compressed air at full line pressure directly through the tool to the drilling face. Heavy blast blows the hole clean, prevents "stuck steels."

Thor SINKER ROCK DRILLS

30 lb.
No. 28

Ideal for light to medium drilling and block holing up to 6 feet deep. For coal mining, can be equipped with side exhaust and rotation on the power stroke for augering. Spring wire retainer optional.

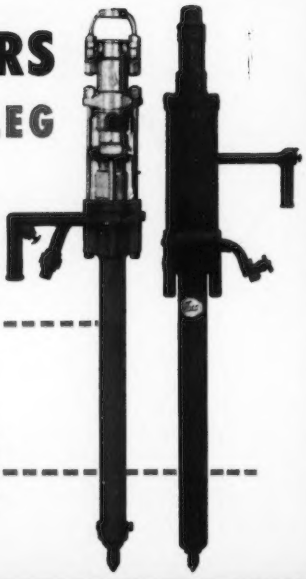
35 lb.
Nos. 33 and 35

These drills are designed for secondary drilling up to 8 feet deep; light weight for drilling horizontal and upward holes. No. 35 is equipped for full line pressure blowing.

45 lb.
No. 38

An all-purpose medium weight Sinker for holes up to 12 feet deep. Mounted on Sinker Leg can be used for Drifting, especially with carbide bits. With Thor Stoper Leg, the No. 38 can be adapted to stoping.

Thor STOPERS and STOPER LEG



STOPER LEG

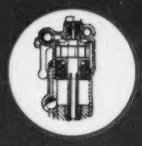
Supports and feeds Sinker Rock Drills for overhead drilling. Can be used with Thor No. 38 or 48 Rock Drills, simply by removing two bolts and backhead. Order No. 51 Stoper Leg. Weight 46 lbs. 18" steel change.

STANDARD AND REVERSE FEED STOPERS

Three sizes, six models with standard or reverse feed to handle all stoping and other overhead drilling operations. Reverse feed permits machines to be used in horizontal positions on pneumatic columns. (See photo, left).

ENDLESS PISTON LIFE — Years of practical field experience show piston breakage practically eliminated in Thor Rock Drills; amazing life for contacting surfaces.

AUTOMATIC LUBRICATION — Automatic lubricator passes all air pressure through all moving parts with every operation of the piston [illegible]



AUGER ROCK DRILLS

55 lb.
Nos. 72 and 75

For drilling holes up to 20 feet deep in hardest rock. Recommended for shaft sinking. Can be used with Thor Sinker Leg or Air Bar Feed for economical carbide bit drifting. No. 75 uses collared steel, No. 72 for steels with round lugged shank or tappet construction for plain shank hexagon steels.

80 lb.
No. 85B

A husky, powerful Sinker for heaviest duty service in hardest rock, where conditions calls for a hand held drill to sink holes up to 25 feet deep. Recommended for heavy duty shaft sinking.

35 lb. **No. 139**

45 lb. **No. 48**

Equipped with augering rotation on the power stroke. Recommended for all iron, bauxite and anthracite mines, and for tunneling through shale and slate, cemented gravel, talc, clay and other loose or broken formations. (See also 30 lb. No. 28 Drill).

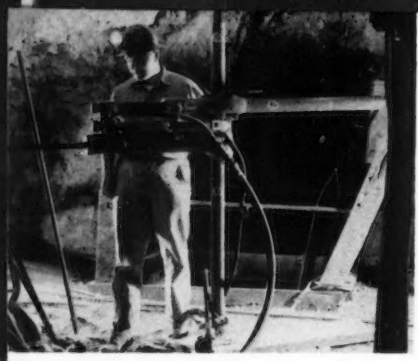
Thor POWER-FEED DRIFTERS

POWER UNIT operates drill on shell independently of Drifter—no vibration during rapid advance or return . . . no recoil, positive spring cushion stop, better balance — for LONGER TOOL LIFE.

- Perfect power for carbide bit drilling.
- Perfect control at ALL drilling speeds.
- 25% more efficient by actual mine tests!

New development provides full power at slowest speeds: drill starts moving immediately upon opening of motor throttle . . . from fast drilling down to a 2-inch per minute crawl. Ideal for carbide bit drilling . . . and for jumbo mounting.

THREE SIZES: RF-48, 24" + 24" feed; RF-60, 30" + 30" feed; RF-96 (aluminum), 48" + 48" feed.

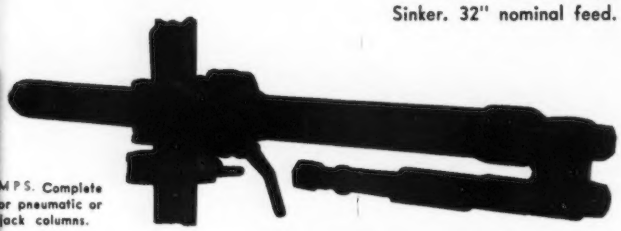


PNEUMATIC COLUMNS. Exclusive four-foot travel eliminates timbering. Safety throttle and spring-actuated check-valve prevent accidental collapse of column. Two-prong foot standard; four-prong foot available for extra stability when using arms. Accommodate air bar feeds, reverse feed stopers, hand or power feed drifters. Three sizes: TC-6 (6 to 10 ft.); TC-8 (8 to 12 ft.); TC-10 (10 to 14 ft.)

Thor AIR BAR FEEDS

For mounting on Thor Pneumatic Columns (see photo, left), or on 3" or 3½" screw jack column and arm, cross bar or jumbo set up.

Converts hand-crank Drifters — and Sinkers — to power feed, forward and reverse. Feeds from any position, in any direction. Four models available for drifting, stoping and sinking with Thor Nos. 82 and 92 Drifters, No. 75 Sinker. 32" nominal feed.

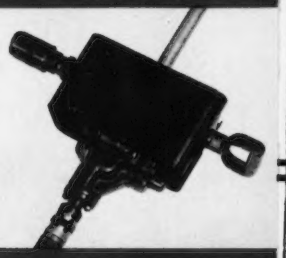


CLAMPS. Complete line, for pneumatic or screw-jack columns.

AIR BAR FEED supports and feeds Drifters and Sinkers.

ROOF BOLTING TOOLS
STOPERS BOLT DRIVERS
IMPACT WRENCHES

WAGON DRILLS



COAL DRILLS

SAWS

Thor SUMP PUMPS

Self-priming . . . operate efficiently in dirty water, oil . . . partially or fully submerged. Exclusive large capacity lubricating system lubricates all moving parts up to a full shift. Two sizes.

361T. A medium size pump most effective up to a 60 foot head (114 gal. per min. at 60 ft. head, 90 lbs. pressure). Can be furnished to operate in tandem, pumping up to a total head of 160 feet at 90 lbs. pressure.

381T. For continuous heavy duty pumping to high levels (50 gals. per min. at 160 ft. head, 90 lbs. pressure).

COMPLETE LINE OF PNEUMATIC AND ELECTRIC HAND TOOL

SAWS

IMPACT WRENCHES

DRILLS AND WOOD BORERS

GRINDERS

HAMMERS

Printed in U.S.A.

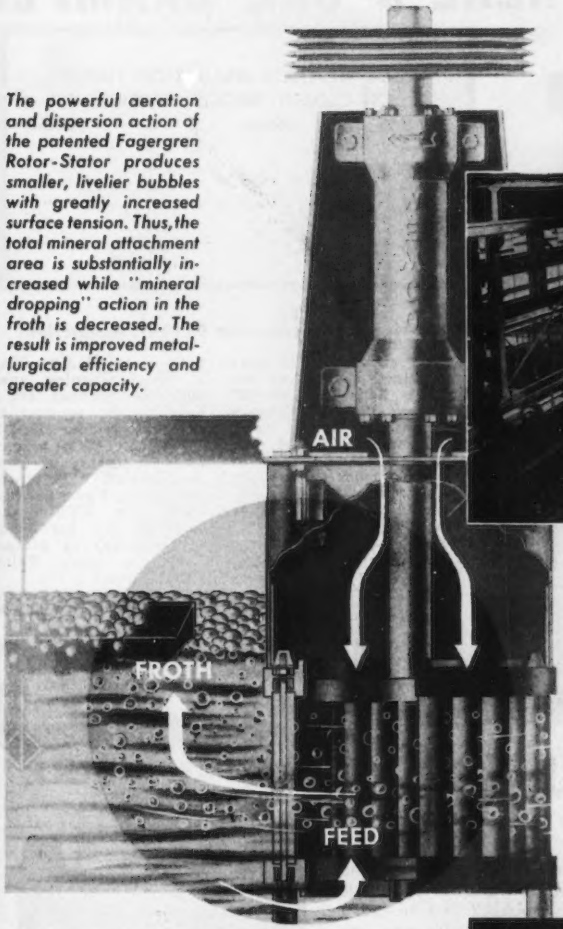
J.E. 11

INDEPENDENT PNEUMATIC TOOL COMPANY • AURORA, ILL.
BIRMINGHAM BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DENVER DETROIT HOUSTON
LOS ANGELES MILWAUKEE NEW YORK PHILADELPHIA PITTSBURGH ST. LOUIS ST. PAUL
SALT LAKE CITY SAN FRANCISCO SEATTLE LONDON, ENGLAND SAO PAULO, BRAZIL TORONTO, CANADA

WITH FAGERGRENS—

every bubble works!

The powerful aeration and dispersion action of the patented Fagergren Rotor-Stator produces smaller, livelier bubbles with greatly increased surface tension. Thus, the total mineral attachment area is substantially increased while "mineral dropping" action in the froth is decreased. The result is improved metallurgical efficiency and greater capacity.



Experienced operators know that flotation results depend on the number and type of mineral-carrying bubbles. The Fagergren Flotation Machine gets <u>better</u> results — superior mineral extraction — because it produces a greater number of <u>effective</u> bubbles than any other type machine.

The installation of Fagergren Flotation Machines in the three largest U. S. copper concentration mills testifies to its superior efficiency and wide acceptance. These and many other Fagergren installations provide practical evidence of five outstanding features:

1. Higher mineral recovery and grade of product achieved by more thorough contact between pulp and air.
2. Greater capacity per dollar of capital investment.
3. Lower reagent cost — as much as 50% saving — due to greater aeration and faster mineral removal.
4. Less power consumption per ton of feed.
5. Reduced operating costs resulting from simpler design made possible by the rotor-stator principle.

Write today for new brochure on the Fagergren Flotation Machine and for specific information to help solve your flotation problem.

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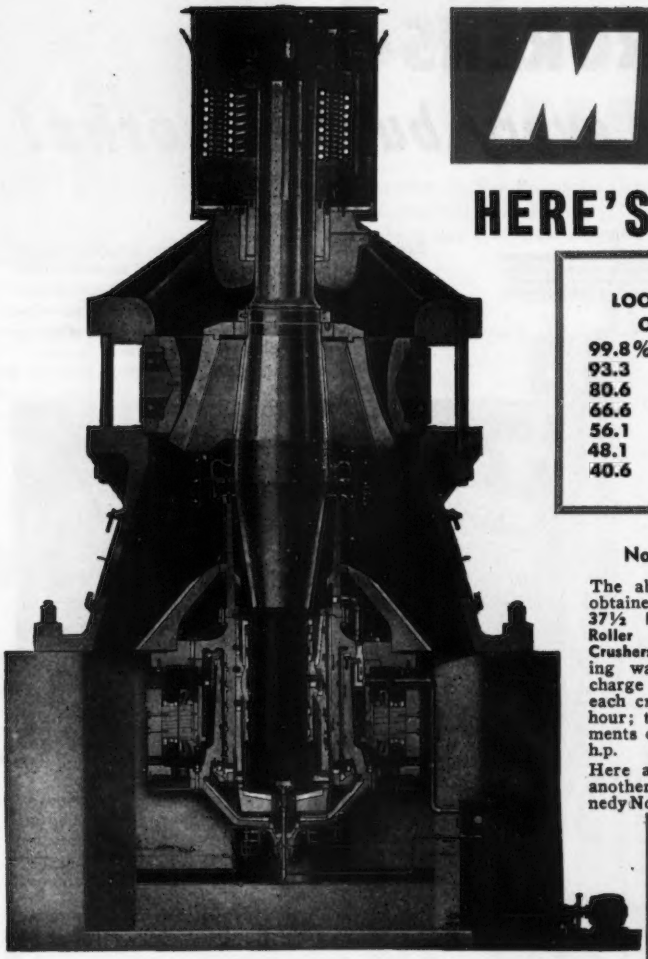
MOBIL-MILLS	FAGERGREN & STEFFENSEN FLOTATION MACHINES	DEWATERING SPIRALS
COAL SPIRALS	FAGERGREN LABORATORY UNITS	AGITATORS
HMS THICKENERS	HYDROSEPARATORS	S-H CLASSIFIERS
HMS PUMPS	HMS LABORATORY UNITS	THICKENERS
DENSIFIERS		SAND PUMPS
CONE SEPARATORS		CONDITIONERS
DRUM SEPARATORS		



MORE

HERE'S ONE EXAMPLE

LOOK AT THESE GRADATION FIGURES ON CLOSED CIRCUIT OPERATION

99.8%	Minus	3	MESH
93.3	"	4	"
80.6	"	6	"
66.6	"	8	"
56.1	"	10	"
48.1	"	14	"
40.6	"	20	"

Not only more—but BETTER production!

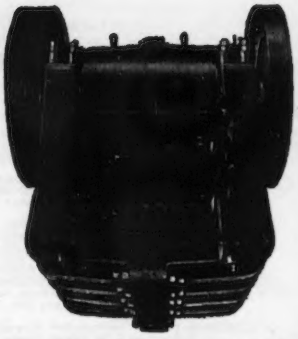
The above results were obtained from four **No. 37½ Kennedy type "S" Roller Bearing Gyratory Crushers.** The feed opening was 6¼", the discharge 7/32". Capacity of each crusher 56 tons per hour; the power requirements of each crusher 48 h.p.

Here are the results of another test run! A Kennedy No. 37½ Crusher with a Special Grinding Ring 3" Feed Opening gave 50% more product (and a finer, better product at that) for about HALF the power cost of a competitive crusher of comparable size. With power costing say 1 cent per h.p. hour, this KVS saved some 40 h.p. (or about $11.00 daily) or around $3,000 a year. Think THAT over!

MORE

CRUSH MORE--*EASIER*

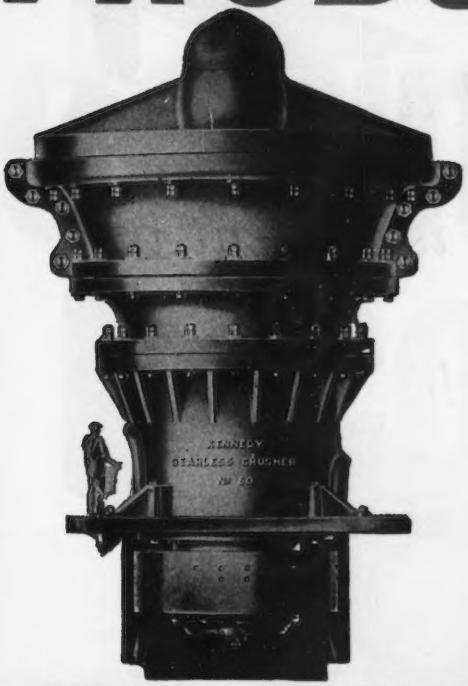
There's less wasted power and effort in the "KVS" SWING JAW CRUSHER since we redesigned the STATIONARY jaw to carry 50% of the crushing load. Result—you get more production and get it more efficiently. We looked into MAINTENANCE too. The swing jaw is now ALL IN ONE PIECE, except for the crushing plate. That's removable. Note also—Swing and Stationary jaws are INTERCHANGEABLE, and reversible end for end. That DOUBLES jaw-crushing life while your production keeps right on mounting.



MORE PRODUCTION!

MEANS "KVS" EVERY

PRODUCTION!



HERE'S HOW "KVS" GIVES YOU FREE ADDED POWER

FOR MORE PRODUCTION

In the "good old days," the big whirling flywheel or pulley of an old Corliss Engine developed added extra KINETIC ENERGY! That meant added FREE power! TODAY the BIG Revolving Pulley in the "KVS" Gearless does the same thing. It revolves at 3,500 ft. per minute—creates EXTRA crushing power for more production—in fact you get it like a bonus! The 11 ton pulley (used in a "KVS" Gearless Crusher weighing 400,000 lbs.) turns so easily you can turn it on its roller bearings with TWO FINGERS! Look here, man—more CRUSHING with LESS POWER, less vibration and less NOISE, too, has put the "KVS" Gearless way out in front when it comes to added production—and keeps it there!

PRODUCTION!

AND FOR *LESS* DOLLARS

Is your production dependent on a 10′ diameter ball mill? If so, you can save up to $5,000 by buying a "KVS" Mill with integral gear drive and using a SYNCHRONOUS MOTOR DIRECT CONNECTED to driving shaft carried in roller bearings that CANNOT be misaligned or set wrong. Pinion shaft runs at about 600 r.p.m. Pinion shafts in other mills run at about 180 r.p.m. "KVS" trunnions on large sized tube and ball mills CARRIED ON OIL. Bearing never wears out, uses little power. All gears and bearings automatically oil sprayed before mill is started (design pat'd). In 15 years on this type mill no "KVS" gears or pinions have worn out. Send for all "KVS" Bulletins for complete data.

Kennedy-Van Saun

MANUFACTURING AND ENGINEERING CORPORATION

2 PARK AVE., NEW YORK 16, N. Y.

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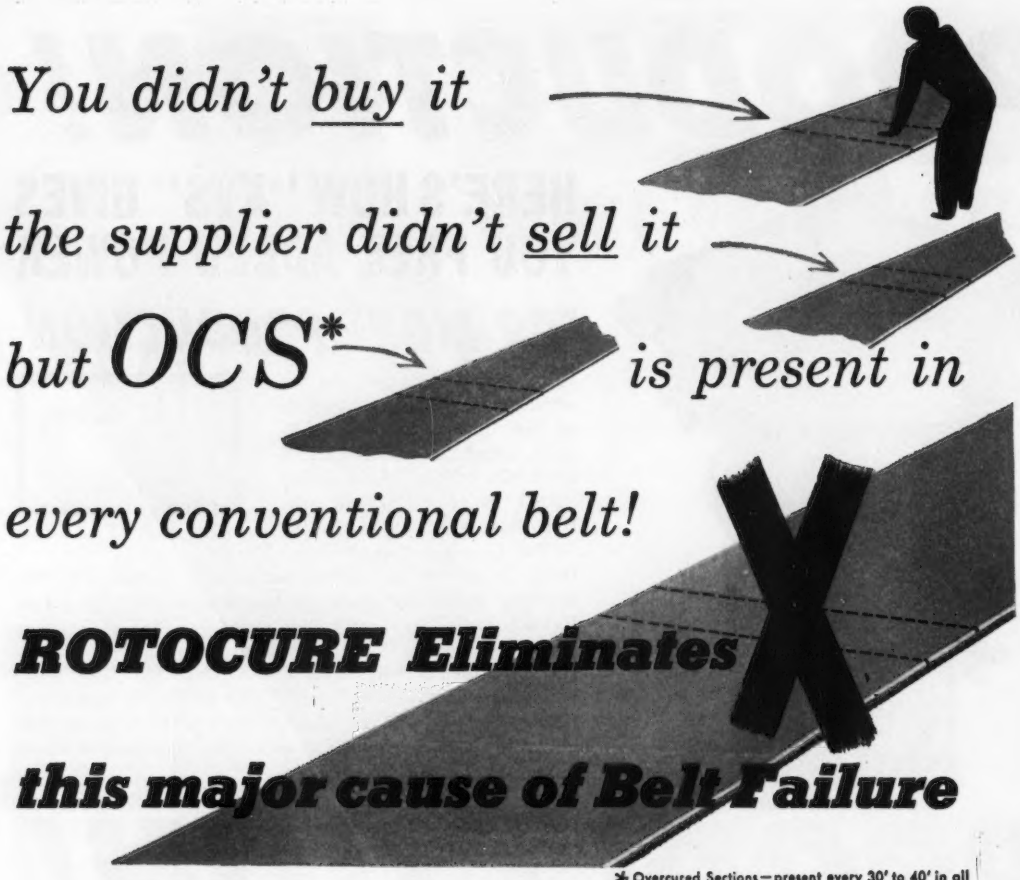
TIME—YES SIR!

You didn't buy it

the supplier didn't sell it

but OCS is present in*

every conventional belt!



ROTOCURE Eliminates

this major cause of Belt Failure

* Overcured Sections—present every 30' to 40' in all belts made by the flat press method. Only Rotocuring eliminates this major cause of belt failure.

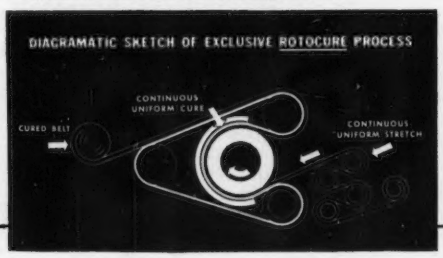
Many of the premature failures of conventionally-made conveyor belts can be attributed to *overcured* or *double-cured* segments of 2" to 4" wide across the entire belt. These "Achilles Heels" occur every 30 to 40 feet and cannot be eliminated in conventional or flat press curing because the earlier cured sections in this "stop and go" operation move forward *less than a full press length* each time.

Realizing that continuous vulcanization was the solution (and the *only* solution) to this problem, BWH technologists developed ROTOCURE. In this BWH *continuous* curing process, press overlapping is impossible, overcuring is completely eliminated and flex life steps up as much as 40%.

What's more, users of BWH ROTOCURED belts have found that ROTOCURE eliminates mechanical distortion at the press ends . . . assures constant, uniform stretch . . . provides uniform, abrasion-resistant covers.

It all pays off in longer belt life, less maintenance and appreciable cost per ton savings in material conveyed. Ask your BWH distributor or write us direct.

You'll find these advantages in BWH rotocured transmission belts, plus a higher coefficient of friction since no dusting agents are needed. Because of this, you can operate at lower tensions — an additional factor contributing to longer belt life.



BWH DEPENDABLE RUGGEDNESS

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

Distributors in all Principal Cities

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down come costs

These two P&H Electrics serve the same steel-making operation at Birmingham, Alabama. The Model 1600, owned by the Birmingham Slag Company, is loading blast furnace slag. The Model 1400, digging fluxing stone, is owned by the Stockbridge Stone Company.

with P&H ELECTRIC SHOVELS

Wherever these new P&H Electrics take over, costs go *down!* It couldn't be otherwise, with all the improvements that make for faster, smoother, more dependable digging.

There's Magnetorque* Hoist Drive, which gives you snappier dipper action with electro-magnetic power — completely eliminates hoist generator, hoist motor, slip friction clutch, and other mechanical devices.

There's P&H stepless power regulation — smoother, more accurate — and no control fingers or contactors to require maintenance or give you trouble.

There's tough, all-welded construction for extra strength without excess weight.

There's more — *much more* — see a P&H before you invest in new equipment of this type.

* Trade-mark of Harnischfeger Corporation for electro-magnetic type clutch.

P&H
HARNISCHFEGER CORPORATION

ELECTRIC SHOVELS
4454 W. National Avenue
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Every third P&H Electric Shovel sold is a repeat order

POWER SHOVELS • CRAWLER AND TRUCK CRANES • OVERHEAD CRANES • HOISTS • ARC WELDERS AND ELECTRODES • SOIL STABILIZERS • DIESEL ENGINES • PRE-FAB HOMES

Be prepared

M·S·A

THE M·S·A PNEOLATOR

for rapid recovery in all cases of

ARRESTED BREATHING

Here is one of the most important contributions to mine life-saving equipment in a decade—the M.S.A. Pneolator.

The Pneolator assures maximum chances of recovery to miners overcome by poisonous gases or asphyxiated from any other cause. It automatically provides oxygen for the lungs at the pre-selected amount and pressure, continuously—rhythmically—effectively—and safely!

The complete elimination of any "suction" relieves the danger of aggravating injured lung tissues; exhalation takes place by the *normal* passive return of the respiratory muscles. The Pneolator can be converted immediately to inhalator action when the patient starts breathing without any interruption of the treatment.

Housed in a rugged, light weight carrying case, the Pneolator can be conveyed immediately to the patient . . . conserving the minutes that may make the difference between recovery and tragedy. A demonstration can be arranged. Ask for Bulletin No. CH-2.

(NOTE) *The first few minutes after breathing has ceased are the most critical. Immediate application of manual artificial respiration should be started and continued until the Pneolator is in use.*

MINE SAFETY

for Emergencies...with this

Breathing Protection

for the RESCUE team

M·S·A CHEMOX®

Providing complete breathing protection in any atmosphere for a minimum of 45 minutes, the M.S.A. Chemox permits immediate emergency rescue operations by men near the scene. Chemox generates its own oxygen supply from a chemical cartridge—all the wearer does is breathe. It weighs only 13 lbs.

The replaceable canister can be stored indefinitely without deterioration, assuring instant availability when needed. Bureau of Mines Approval No. 1307. Ask for Bulletin No. B-14.

M·S·A "ALL-SERVICE" MASK

Here's approved, dependable breathing protection wherever sufficient oxygen is present in mine atmospheres. Designed for both comfort and performance, the "All-Service" Mask affords protection against smoke, poisonous gases and fumes, including carbon monoxide, singly or in combination. Easy to put on and adjust, the "All-Service" Mask can be equipped with a "Clearvoice" Speaking Diaphragm for clear conversation between mask-wearers.

M·S·A McCAA TWO-HOUR TYPE

Under the hardest physical conditions, so often required in fighting and sealing mine fires, re-establishing ventilation, and rescue operations, the McCaa Two-Hour Oxygen Breathing Apparatus gives the wearer complete breathing protection in any unbreathable atmosphere for a minimum of two hours. U.S. Bureau of Mines Approved. Write for Bulletin No. BB-3.

When you have a safety problem, M.S.A. is at your service. Our job is to help you.

APPLIANCES CO.

BRADDOCK, THOMAS AND MEADE STREETS
PITTSBURGH 8, PA.

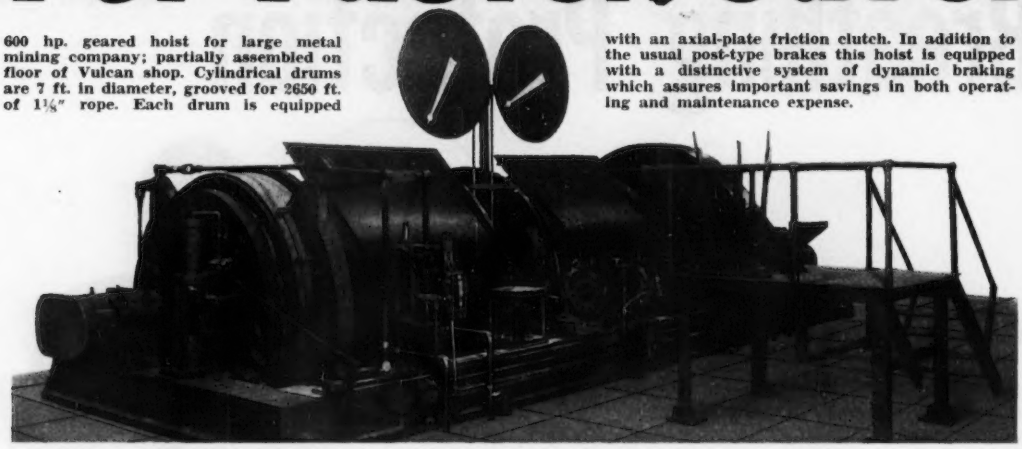
At Your Service

54 BRANCH OFFICES IN THE UNITED STATES AND CANADA

MSA
SAFETY EQUIPMENT HEADQUARTERS

For Faster, Safer

600 hp. geared hoist for large metal mining company; partially assembled on floor of Vulcan shop. Cylindrical drums are 7 ft. in diameter, grooved for 2650 ft. of 1⅛" rope. Each drum is equipped with an axial-plate friction clutch. In addition to the usual post-type brakes this hoist is equipped with a distinctive system of dynamic braking which assures important savings in both operating and maintenance expense.



Each of these three bulletins contains a wealth of specific information. Write for free copies if you can use them to advantage. Fully illustrated.

Vulcan Hoists and Sheaves

Illustration above shows a Vulcan Allcasteel sheave mounted on self-aligning roller-bearing pillow blocks. Another popular type has tapered roller bearings in the hub and revolves around a dead shaft held in clamp-type steel pedestals.

Besides being light and very strong, Vulcan Allcasteel sheaves are so resistant to rope wear that liners are seldom needed. Manganeese steel liners are furnished, however, when specified by the purchaser.

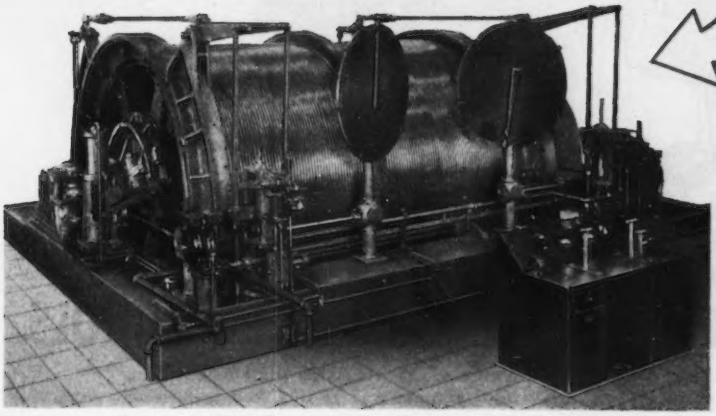
Vulcan Electric Hoists are available in all types and sizes from 5 hp. to 5000 hp., to meet any requirement of the mining industry. Bed plates and frames can be of either cast iron, cast steel or fabricated steel plate, as preferred by the purchaser. Modern design, sturdy construction and dependable safety devices promote efficient operation and permit high-speed hoisting without strain on the operator.

Vulcan Allcasteel Sheaves are cast and heat-treated in our own steel foundry and machined to perfect balance, in sizes up to 24 ft. p. d. on our own large boring mills. Used by leading mining companies for more than a quarter of a century, they have thoroughly proved their superiority for long time heavy-duty service. All types and sizes available with either plain or anti-friction bearings.

VULCAN

MANUFACTURERS, ALSO, OF ALL TYPES OF MODERN LOCOMOTIVES . . . WRITE US

HOISTING



Roller-Bearing Electric Hoist for metal mine, assembled in Vulcan shop. To be driven by dual 250 hp. motors (not shown in illustration) through flexible couplings and single-reduction herringbone gears running in oil. Main shaft and pinion shafts mounted in spherical-roller-bearing pillow blocks. All operating levers and instruments grouped at control desk on floor level.

Equipped with parallel-motion post-type brakes on each drum and toothed-type positive clutch on one drum. Brake and clutch engines operated by oil-hydraulic pressure. Clutch and brake on loose drum mechanically and electrically interlocked. All-steel drums are 10'-0" diam. by 6'-2" face, with machine-cut grooves for 1609 ft. of 1¾" rope in one layer. Each drum is equipped with a gear-driven safety controller which provides complete protection for hoisting from several different levels.

Vulcan Cages and Skips

During our century of service to the mining industry so many different types of cages, skips, gunboats, etc., have been built that practically any requirement along those lines can be taken care of by using some well-proved Vulcan design—often with very little modification. Whenever necessary, however, new designs are developed to meet the purchaser's operating conditions and requirements.

Recent designs include the use of lightweight metals, high-strength alloy steels, shock-absorbing rubber interliners and improved safety devices; all of which increase hoisting capacity and reduce maintenance expense.

Three-Deck Man Cage with pneumatic tires on guide wheels.

Combination Man Cage and Automatic Bottom-Discharge Skip.

SOME PROMINENT USERS of Vulcan Hoisting Equipment in the Metal and Non-Metallic Mining Fields

Alan Wood Steel Company
Algoma Steel Corp. Ltd.
American Metal Co., Ltd.
American Smelting & Refining Co.
Anaconda Copper Mining Co.
Andes Copper Mining Co.
Bethlehem Steel Corporation
Canadian Mining & Finance Co.
Cerro De Pasco Copper Corp.
Chateaugay Ore & Iron Co.
Cleveland Cliffs Iron Co.
Consolidated Mining & Smelting Co.
Detroit Rock Salt Co.
Dominion Steel and Coal Corp.
Federal Government of Mexico
M. A. Hanna Company
Hollinger Cons. Gold Mines Ltd.
Homestake Mining Company
Howe Sound Company
Hudson Bay Mining & Smelting Co. Ltd.
International Minerals & Chemical Corp.
Jones & Laughlin Steel Corp.
Lawrence Portland Cement Co.
National Gypsum Company
National Portland Cement Co.
New Jersey Zinc Company
Newmont Mining Corp.
O'Kiep Mining Company
Phelps-Dodge Corp.
Republic Steel Corp.
Richard Ore Company
Sloss-Sheffield Steel & Iron Co.
Tennessee Coal, Iron & Railroad Co.
Tennessee Copper Company
Tsumeb Corp. Ltd.
Union Potash & Chemical Co.
Universal Trading Corp.
U. S. Smelting, Refining & Mining Co.
Warren Foundry & Pipe Corp.
Weirton Steel Co.
Woodward Iron Co.
Youngstown Sheet & Tube Co.

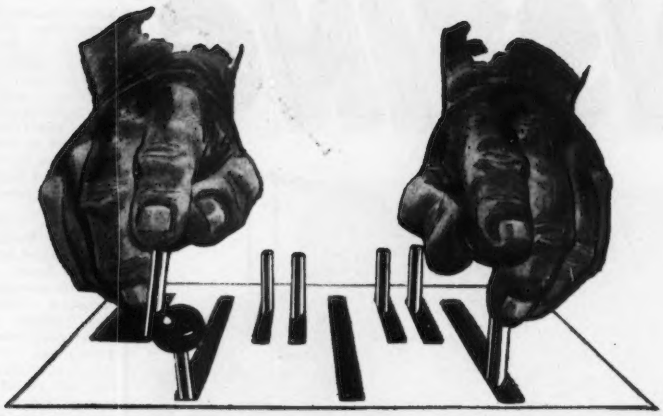
Note: above list does not include equally prominent users in the coal mining field.

IRON WORKS

ESTABLISHED 1849

WILKES-BARRE, PA., U.S.A.

REGARDING ANY REQUIREMENT FOR EITHER UNDERGROUND OR SURFACE HAULAGE



At your fingertips... up to 25% increased output with

SMOOTHER, EFFORTLESS, *Speed-o-Matic* CONTROLS

Fingers instead of muscles do the work with Link-Belt Speeder's exclusive Speed-o-Matic* controls! Every move of Shovel-Crane is faster, more accurate, easier. You get "pin point" placement of bucket, shovel or hoe. No drag or lag, jerk or jump. You "feel the load" every inch of the way—smoothly, surely, safely.

As for your operator, what a difference this control makes! He's fresh and fit, even during long overtime. And he lifts, loads and swings with a tireless precision that pays off in greater output, more profits for you.

Only Link-Belt Speeders offer you the unequalled advantages of Speed-o-Matic *full* hydraulic controls. Look to Link-Belt Speeder for more work, more kinds of work, more of the time.

* On 51, 300 and 500 series.

K-595 stripping overburden
Tremendous power, stability and swift, easy Speed-o-Matic control makes this K-595 ideal for high output in mining operations. In dragline work the Independent Rapid Boom Hoist, powered both up and down makes long throws, fast hoisting and swinging simple routine. Rugged construction assures low maintenance.

12,971

LINK-BELT SPEEDER
CORPORATION

Builders of the most complete line of shovels, cranes and draglines
CEDAR RAPIDS, IOWA

GET THE MOTOR that Cleans Itself

DROP YOUR MAINTENANCE COSTS to a new low by reducing motor cleaning operations and reducing inspections and overhauls. Tests have proved that on most applications totally-enclosed, fan-cooled motors more than pay back their extra cost in reduced maintenance. And this new Allis-Chalmers Type APZ tefc motor makes maintenance costs lower than ever before on this type of motor.

Here's Why

Concealed air passages and pockets have been eliminated; dirt cannot build up to cause overheating. Cooling air is blown over the ribbed cast iron frame and bearing housings carrying dirt away with it. How about oily dirt that sticks? It can be wiped or blown off without stopping the motor.

Rigid Construction

The frame is rigid cast iron which not only has high inherent corrosion resistance, but also holds bearings in alignment. Bearings are pre-lubricated at the factory and should need no attention for years. Tapped holes with pipe plugs to permit regreasing and to provide grease relief are standard equipment.

Get All The Facts

The new Allis-Chalmers Type APZ totally-enclosed fan-cooled motor is built in all NEMA standard frame sizes from 224* to 505. Also in explosion-proof type. Your A-C Authorized Dealer or District Office has complete information. Call today, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B6144. A-3398

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

ALLIS-CHALMERS

*Similar design non-ventilated motors Type APK, also available in frames 203 to 224 inclusive.

Quick pick-up for miners steps up production

In just one hour, 100 feet of the flexible tubing shown above will be installed, ready to bring cool fresh air up to the men at the face—helping to speed the production cycle. Du Pont "Ventube" flexible duct for auxiliary ventilating systems *helps clear the working face quickly* after blasting. That means fewer lost minutes, more tons per hour from drifts, crosscuts, shafts, cavings, top-slicing.

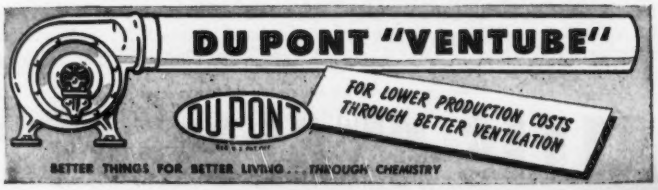
Du Pont "Ventube," coupled to a motor-driven fan of adequate capacity, drives out stale humid air . . . helps miners shake off sluggishness that slows down work.

Flexible in use. "Ventube" goes around curves, up and down slopes. Takes up less room in openings. Directs air to the working face. Easy to move and to keep up with the work. Easy to store.

Low initial cost (much less than rigid-type auxiliary ventilating systems). One man can easily install 100 feet per hour with patented couplings to make the air-tight connections easily.

For further information on ways to increase your mine efficiency with "Ventube," just write to: E. I. du Pont de Nemours & Co. (Inc.), Fabrics Div., Empire State Bldg., New York 1, N. Y.

*"VENTUBE" is Du Pont's trade mark for its flexible, synthetic-rubberized fabric ventilating duct.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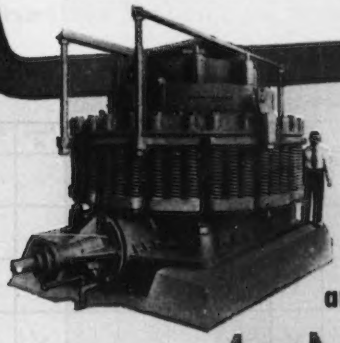
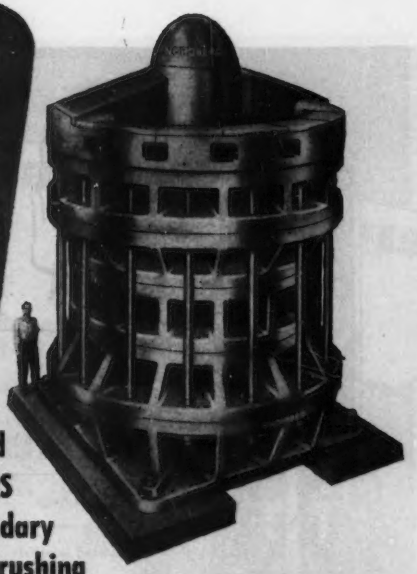
FOR LOWER PRODUCTION COSTS THROUGH BETTER VENTILATION
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

NORDBERG

MACHINERY FOR THE MINING INDUSTRY





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MINE HOISTS

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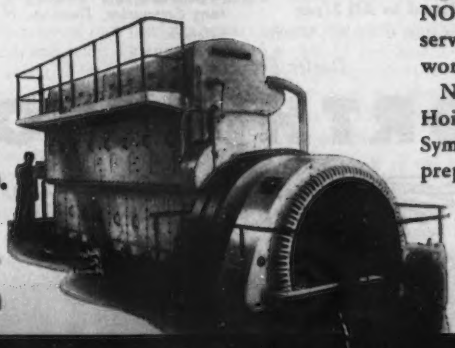
2 and 4-cycle,
0 to 9600 hp.
Burn Gas, Oil
or any Combi-
nation of Both



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NORDBERG MACHINERY includes Mine Hoists; Gyratory Crushers for primary breaking; Symons Standard and Short Head Crushers for preparation of finely and uniformly sized mill feed; Vibrating Grizzlies and Screens for scalping and sizing; and Grinding Mills.

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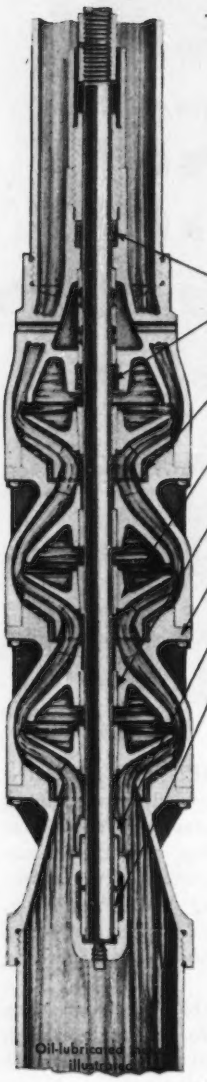
NORDBERG MACHINERY

Before you buy a vertical turbine pump

CHECK WORTHINGTON AGAINST THE FIELD!

Chart shows only Worthington gives you all 8 vital design-features as standard equipment



The Ten Leading Makes Of Vertical Turbine Pumps
√ Indicates Feature Is Standard

Standard Features	Worthington Type Q	Pump A	Pump B	Pump C	Pump D	Pump E	Pump F	Pump G	Pump H	Pump I
Seals above and below drain ports (oil-lubricated model)	√									
Wearing rings	√				√			√		
Enclosed impellers	√	√	√	√	√	√		√	√	√
Bronze bushings in bowl assembly	√		√	√	√	√		√	√	√
Flanged and bolted bowls on all sizes	√						√		√	√
Sand collars at both ends of bowl assembly (water-lubricated model)	√	√								
Grease-packed bottom bearing	√	√			√					√
Choice of oil or water lubrication	√	√	√	√	√	√		√		

There's your quick, complete picture of how Worthington Type Q stocks up against competition. Remember — each of the features listed is a proved aid to more efficient pump performance. And only Worthington gives you all of them as standard!

Why settle for anything less than this all-inclusive, ahead-of-the-parade design that assures smoother, lower-cost pumping?

Maximum Head In All Sizes

Available in sizes from 6" to 32", Worthington Type Q Vertical Turbine Pumps handle liquids at temperatures of 7° below zero F to 500°F, with maximum head per stage over the entire size range.

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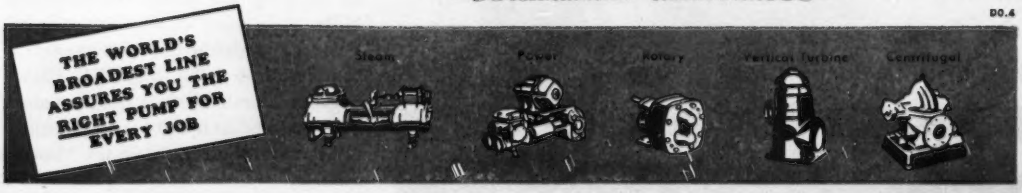
THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB



Can You Use These Facilities?

THE ALLIS-CHALMERS Basic Industries Research Laboratory is open for business — to help you work out profitable solutions to processing problems. It contains modern equipment for both batch and pilot mill tests in grinding, crushing, sizing, concentrating, jigging, pyro-processing, as well as chemical and physical analysis.

The Laboratory's purpose is to develop new or more efficient processing methods . . . to determine the economics of a process prior to full scale production . . . to provide engineering information to guide in the designing of efficient plants.

Use of the facilities of the laboratory are available to anyone in industry. Charges are based on costs. Estimates for test work can be obtained from the A-C district office in your area or by writing direct to Allis-Chalmers Research Laboratory, Milwaukee 1, Wisconsin.

HERE'S HOW LABORATORY SERVICE WORKS:

A manufacturer of rock products wanted to crush and grind a granite rock to produce material for roofing granules.

A considerable amount of equipment would be required, and before making this expenditure the company wanted to be sure that not too much material would be lost as fines in the process. It was estimated that a 50 percent recovery would be commercially practical.

The problem was brought to the Allis-Chalmers Basic Industries Laboratory for crushing and grinding tests. A ton of the granite rock was run through the Laboratory's pilot mill and a flow sheet was worked out which resulted in 70 percent recovery of finished product.

As a result of the tests, this manufacturer was able to proceed with confidence in setting up new equipment . . . with only a nominal expenditure for preliminary pilot plant testing.

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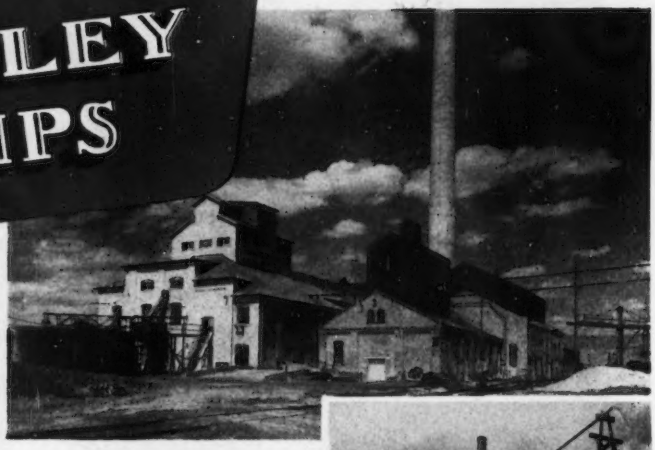
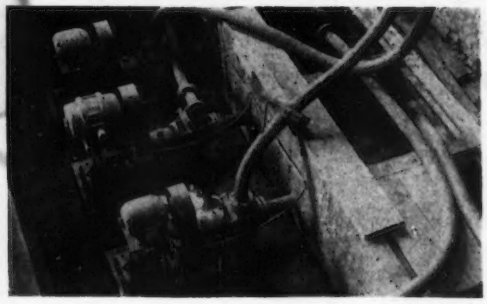
WILFLEY PUMPS

Used At...

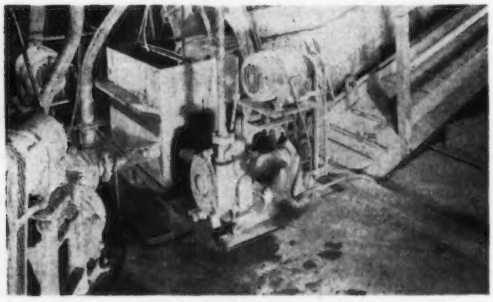
Climax URANIUM PLANT



The great CLIMAX URANIUM COMPANY PLANT at Grand Junction, Colorado, built primarily for uranium processing, uses WILFLEY pumps throughout. WILFLEY Model K sand, Model AF acid, and plastic lined acid pumps maintain continuous, trouble-free, high-efficiency performance with leaching solutions, tailings, vanadium and uranium leach liquors, dilute acids, sand slime, roaster calcine and other chemical solutions. Individual engineering on every application. Buy WILFLEY for lower production costs. Write or wire for details.



Plastic Lined Pumps in Tank House. *These acid-proof pumps receive vanadium and uranium leach liquors from leaching tanks and pump them to various treatment tanks located in the main portion of the building.*



Grind Circuit Circulation Model K Pumps. *These sand pumps receive the classifier overflow and pump the material to the sand slime separation circuit located at a higher elevation.*

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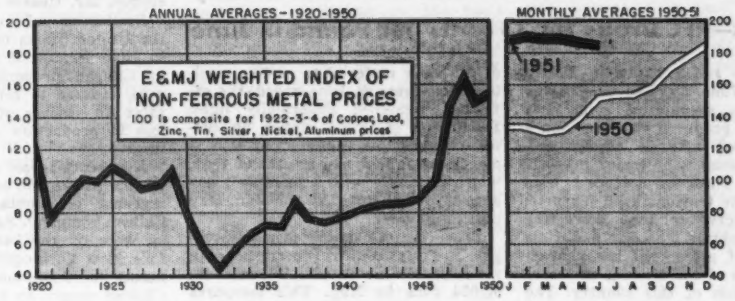
E&MJ OUTLOOK

PRICES



MARKETS

Under the RFC's relentless assault, tin lost 33¢ per lb. in price in a single month, ending June at $1.06. Stuart Symington, RFC's administrator, would like to see tin slide further, but the anguished outcry from Bolivia, and elsewhere, may stop him. Patiño's contentedness with the lower price is not typical.

Tin's collapse drove **the E&MJ index of non-ferrous metal prices** down 2.28 points for June, halting at 187.19. Pressure on copper, lead, and zinc prices is still upward, despite Korean peace talks. But look for price unsettlement in foreign markets, if the war scare lessens. They're a lot more sensitive than today's domestic markets.

•

LABOR

Urgent need for copper and sulphuric acid makes imperative an end to the United Steelworkers' strike at Garfield. Yet the union turned down at Garfield the same terms it accepted at other Salt Lake properties. It could be that the union wanted to get Washington into the act quickly to beat Mine, Mill to the punch with a WSB-approved contract.

•

AT HOME

A Korean cease-fire won't cut off demand for metals. Defense orders in, and on the way, will more than keep plants humming this year and next. Inflation is still the No. 1 problem for the economy.

The titanium industry was buzzing as June ended, over news that Horizons, Inc., teamed up with Ferro Corp., both of Cleveland, are building a pilot plant that they hope will produce titanium sponge for $1 per lb. Present cost is $5. Office of Naval Research won't say how it's done, but does believe Horizons, Inc., can do it. If they can, it's a terrific jump ahead for an extremely important metal.

Harvey Machine Co. may be an aluminum producer before long if its plans work out for using Dutch East Indies bauxite and Montana power for a 35,000-ton-a-year aluminum plant near Kalispell.

•

ABROAD

Gold in the Paris free market droops as peace hopes rise. Experts now think the price may sag below $40 an ounce if peace seems secure. They've been regarding $40 as rock bottom, up to now.

ECA's $15.5 million loan to the Belgian Congo for raw material development, and that agency's plans to advance $9 million to develop a new copper and cobalt mine in Northern Rhodesia, owned by Mufulira, add to the growing importance of Africa in the world mineral picture.

MARKETS—Trends and Prices

Cease-Fire in Korea Lifts Tension in Commodity Markets—RFC Drops Tin 33 cents per Pound in June

RUSSIA'S BID FOR A TRUCE in Korea, announced June 23, had a sobering influence on speculative commodity markets but produced no more than a "wait-and-see" attitude among sellers and consumers of major non-ferrous metals. However, a truce is likely to ease the tension in all markets. It should serve to tone down the scramble to obtain strategic materials regardless of price that has characterized much of the trading in recent months outside of this country. The defense program here will be pushed to the limit, regardless of Korea, which points to continued extraordinary demands for war materials. Shipping conditions, on land and sea, should improve.

Temporary unsettlement in the price of foreign silver and a sharp drop in tin, engineered by RFC, caused the E. & M. J. index of non-ferrous metal prices to decline from 189.47 in May to 187.19 in June. Domestic quotations for copper, lead and zinc remained strong and well below world levels.

The Controlled Materials Plan for steel, copper and aluminum, originally scheduled to begin July 1, was postponed to July 7. Officials in Washington believe the plan cannot become fully effective for some time because of the work attached to processing 40,000 individual forms filled out by producers of civilian goods other than durables. It was felt that NPA is moving toward complete allocation of the key metals, as the original open-end plan cannot be made to function properly.

Production of steel, according to NPA, is currently at the rate of 20 million tons a quarter; with copper and copper-base alloys at 1,065 million pounds; and aluminum at 538 million pounds.

Copper Scrap Rollback

The long-awaited order fixing ceiling prices on copper scrap was issued during the month and became effective on June 26. Prices were rolled back by OPS to correspond with the differentials that obtained under normal conditions. With primary copper at 24½ cents, delivered, the pricing agency set a ceiling on No. 1 heavy copper and copper wire of 19¼ cents per pound. Clean heavy brass-mill scrap was fixed at 21½ cents per pound. Before the ceiling prices were announced, scrap was selling at prices ranging from 30 cents to 32 cents per pound.

In time, the scrap regulation will divert more material to custom smelters. However, as June ended, the offerings remained abnormally light. Production of crude copper by custom smelters averaged 5,744 tons a month in the first five months of 1951, which compares with a monthly average of 10,134 tons in the Jan.-May period of 1950.

Production of crude primary copper in this country, corresponding roughly to mine output, increased to 90,054 tons in May. This compares with a monthly average of about 78,328 tons in 1950.

U.S. imports of refined copper in the first four months of 1951 totaled 74,934 tons. Exports of refined copper in the same period amounted to 49,243 tons. Imports of blister copper in the Jan.-April period totaled 54,042 tons, and arrivals of copper contained in ore, matte and regulus came to 31,063 tons.

With foreign copper established at approximately 27½ cents, custom smelters have appealed to OPS for price relief on the sale of copper derived from the treatment of foreign-origin copper-bearing material. Without such relief, smelters are threatened with the loss of business. Smelters here would be unable to compete in the open market for foreign material. As June ended, it was fairly certain that OPS will act on this request.

Copper Shortage Acute

Unless a change of pace sets in during the third quarter, the supply of copper that will be available for the civilian economy will shrink steadily. Summarizing the outlook in an address before the Montana School of Mines, W. H. Hoover, president of Anaconda, said, in part:

"The National Production Authority estimated that for 1951 there will be available for all uses of the United States, including stockpile, approximately 1,516,000 tons of copper. We have seen that civilian use alone, at the rate maintained in 1950, could use approximately 1,600,000 tons of copper; that our own domestic primary production, plus secondary intake, is not likely to exceed 1,075,000 tons of copper; and that to reach the anticipated tonnage available for use it will be necessary to import close to 450,000 tons." Average requirements for the year of military and military supporting programs may reach 45% of the copper available, and that by the end of the year, when armament production has picked up speed, the requirements may be at the rate of 80% of the total supply, Mr. Hoover said.

Production of copper outside of the United States met with a setback in June because of a "wildcat" strike at Chilean properties. The workers were ordered to return to their jobs after an absence of a week and the loss in production of 10,000 tons or more.

Kennecott began selling its Chilean copper production on June 1 through Agencia de Ventas de Metales, a Chilean company. Sales by that agency were on the basis of 27½ cents f.a.s. New York equivalent. With Kennecott and Anaconda interests selling Chilean copper on a slightly different basis, our daily averages on foreign copper necessarily showed corresponding variations.

Lead Allocation

Lead consumers were informed that NPA intends to allocate the domestic supply of soft and chemical lead for August delivery. The supply situation in lead was such that domestic consumers became eager buyers of

Average Prices for June (E&MJ Quotations)

Copper:	
Electrolytic, domestic, refinery	24.200
Electrolytic, Export, Refinery.	27.374
Lead:	
Common, New York	17.000
Common, St. Louis	16.800
Silver and Sterling Exchange:	
Silver, New York, per oz.....	88.439
Silver, London, pence per oz...	77.071
Sterling Exchange, "Checks"..	280.000
Zinc:	
Prime Western, East St. Louis	17.500
Tin:	
New York Straits	117.962
New York, 99% min.....(e)	116.962
Gold, per oz. U.S. price.....	$35.000
Quicksilver, per flask.....	$210.000
Antimony (E&MJ) (d).....	45.300
Antimony, bulk, Laredo	42.000
Antimony, in cases, Laredo..	42.500
Platinum, refined, per oz....	$90.000
Cadmium (a)	255.000
Cadmium (b)	267.500
Cadmium (c)	280.000
Aluminum, 99% plus, ingot.	19.000
Magnesium, ingot	24.500
Nickel (f)	56.500

Domestic quotations, unless otherwise stated, are in cents per pound. Sterling exchange checks, in cents. Quicksilver, per flask of 76 lb.
(a) Cadmium average based on the producers' quotation.
(b) Cadmium average based on the average of the producers' and platers' quotation.
(c) Cadmium average based on platers' quotation.
(d) Domestic, 5 tons or more but less than carload lot, packed in cases, f.o.b. New York.
(e) Tin content.
(f) F.o.b. Port Colborne, U.S. duty included.

foreign lead outside of this country at premium prices. Evidently they are willing to absorb the cost of the higher-priced foreign lead to maintain output. The principal producer in Mexico sold lead to buyers in this country on the basis of 20½ cents per pound, f.o.b. Laredo or f.a.s. Tampico. This business, concluded in Mexico, involves the payment of freight and the duty by the buyer. Imports of refined lead in the first four months of 1951 totaled 55,134 tons, an average of 13,783 tons a month. During all of 1950, imports of refined lead averaged 36,811 tons a month.

The price situation in lead in the domestic market was unchanged, the quotations continuing on the basis of 17 cents per pound, New York, and 16.80 cents, St. Louis. Lead scrap prices were rolled back to the basis of primary metal. U.S. mine output of lead in April was 33,478 tons, against 37,096 tons in March and a monthly average for 1950 of 35,823 tons.

The position of zinc about parallels that of lead. Allocation is likely because of mounting complications in the way of providing for both military and civilian requirements. The domestic market held at 17½ cents for Prime Western, East St. Louis. Foreign business was noted at 29 cents and upward, f.a.s. Gulf ports.

Tin suffered a loss of 33 cents per pound, settling at $1.06. The RFC, the sole importer and seller, dropped the price to establish a "reasonable" trading basis.

After weakening because of dull business and larger offerings, foreign silver moved back to 90.16 cents an ounce, New York. A supporting factor was Mexico's decision to restrict exports.

Quicksilver was quiet and easier at $210 per flask of 76 pounds.

(*Continued on page 158*)

Major Metals

U. S. DAILY AND AVERAGE PRICES

June 1951	Electrolytic Copper (a) Domestic	Electrolytic Copper (b) Export	Straits Tin New York	Lead New York	Lead St. Louis	Zinc East St. Louis
1	24.200	27.350	136.000	17.000	16.800	17.500
2	No Market	27.425	136.000	17.000	16.800	17.500
4	24.200	27.425	136.000	17.000	16.800	17.500
5	24.200	27.425	136.000	17.000	16.800	17.500
6	24.200	27.425	136.000	17.000	16.800	17.500
7	24.200	27.250	136.000	17.000	16.800	17.500
8	24.200	27.250	129.000	17.000	16.800	17.500
9	No Market	27.250	129.000	17.000	16.800	17.500
11	24.200	27.250	129.000	17.000	16.800	17.500
12	24.200	27.250	129.000	17.000	16.800	17.500
13	24.200	27.250	123.000	17.000	16.800	17.500
14	24.200	27.290	118.000	17.000	16.800	17.500
15	24.200	27.425	111.000	17.000	16.800	17.500
16	No Market	27.425	111.000	17.000	16.800	17.500
18	24.200	27.425	106.000	17.000	16.800	17.500
19	24.200	27.425	106.000	17.000	16.800	17.500
20	24.200	27.425	106.000	17.000	16.800	17.500
21	24.200	27.425	106.000	17.000	16.800	17.500
22	24.200	27.425	106.000	17.000	16.800	17.500
23	No Market	27.425	106.000	17.000	16.800	17.500
25	24.200	27.350	106.000	17.000	16.800	17.500
26	24.200	27.425	106.000	17.000	16.800	17.500
27	24.200	27.425	106.000	17.000	16.800	17.500
28	24.200	27.425	106.000	17.000	16.800	17.500
29	24.200	27.425	106.000	17.000	16.800	17.500
30	No Market	27.425	106.000	17.000	16.800	17.500
AVERAGES FOR MONTH.						
June	24.200	27.374	117.962	17.000	16.800	17.500
AVERAGES FOR WEEK.						
June						
6	24.200	27.383	136.500	17.000	16.800	17.500
13	24.200	27.250	129.167	17.000	16.800	17.500
20	24.200	27.403	109.667	17.000	16.800	17.500
27	24.200	27.413	106.000	17.000	16.800	17.500
CALENDAR WEEK AVERAGES						
June						
2	24.200	27.296	137.800	17.000	16.800	17.500
9	24.200	27.338	133.667	17.000	16.800	17.500
16	24.200	27.315	120.167	17.000	16.800	17.500
23	24.200	27.425	106.000	17.000	16.800	17.500
30	24.200	27.413	106.000	17.000	16.800	17.500

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

June 1951	Sterling Exchange "Checks"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	280.000	90.160	78.500d.	248s.	$35.00
2	(e)	(e)	(e)	(e)	35.00
4	280.000	90.160	78.500d.	248s.	35.00
5	280.000	90.160	78.500d.	248s.	35.00
6	280.000	90.160	78.500d.	248s.	35.00
7	280.000	87.750	78.500d.	248s.	35.00
8	280.000	87.750	76.500d.	248s.	35.00
9	(e)	(e)	(e)	(e)	35.00
11	280.000	87.750	76.500d.	248s.	35.00
12	280.000	87.750	76.500d.	248s.	35.00
13	280.000	87.750	76.500d.	248s.	35.00
14	280.000	87.750	76.500d.	248s.	35.00
15	280.000	87.750	76.500d.	248s.	35.00
16	(e)	(e)	(e)	(e)	35.00
18	280.000	87.750	76.500d.	248s.	35.00
19	280.000	87.750	76.500d.	248s.	35.00
20	280.000	87.750	76.500d.	248s.	35.00
21	280.000	87.750	76.500d.	248s.	35.00
22	280.000	87.750	76.500d.	248s.	35.00
23	(e)	(e)	(e)	(e)	35.00
25	280.000	87.750	76.500d.	248s.	35.00
26	280.000	87.750	76.500d.	248s.	35.00
27	280.000	87.750	76.500d.	248s.	35.00
28	280.000	90.160	76.500d.	248s.	35.00
29	280.000	90.160	78.500d.	248s.	35.00
30	(e)	(e)	(e)		
AVERAGES FOR MONTH					
June	280.000	88.439	77.071	—	35.00
AVERAGES FOR WEEK					
June					
6	280.000	90.160	—	—	—
13	280.000	87.750	—	—	—
20	280.000	87.750	—	—	—
27	280.000	87.750	—	—	—

Calendar week averages, New York Silver: June 2nd, 90.160; 9th; 89.196; 16th, 87.750; 23rd, 87.750; 30th, 88.714.
(e) No market (Saturday).

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices, except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.30c. per pound, the average differential for delivery charges.

(b) Our export quotation for copper reflects prices obtaining in the open market and is based on sales in the foreign market reduced to the f.o.b. refinery equivalent, Atlantic seaboard. On f.a.s. transactions we deduct 0.075c. for lighterage, etc., to arrive at the f.o.b. refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c. to 0.15c. per pound.

Quotations for zinc are for Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West, effective Jan. 1, 1951, commanded a premium of 1.35c. per pound over the current market for Prime Western; Special High Grade 1.50c.

Quotations for lead are for domestic common lead. Corroding lead commands a premium of 10 points.

(c) The daily New York silver quotation reported by Handy & Harman is for silver contained in ores and other unrefined silver-bearing materials, in cents and fractions of a cent per troy ounce. It is determined by Handy & Harman on the basis of actual sales of bar silver .999 fine in amounts of 50,000 ounces or more for nearby delivery at New York, and is usually one-quarter cent below the price paid for such bar silver, this deduction being the allowance for carrying, delivering and marketing. In addition to foreign silver, the quotations also apply to domestic and Treasury silver if such silver enters into the New York market.

The Treasury's purchase price of newly mined domestic silver is 90.5c. per troy ounce 1000 fine, effective July 1, 1946. London silver in pence per troy ounce, basis .999 fine.

(d) U.S. Treasury's gold price. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

Behind the By-Lines . . .

G. P. Luljen

» This "Production for Defense" issue, we vote as this year's "Effort Most Likely To Be Considered Monumental." A blood-sweat-and-tears deal from start (back in December) to finish, the editors have not only given their All to it, they have coaxed major contributions from some of the best men in mining as well. Our thanks to those mining men who really made this issue what it is.

Along with the fun we get out of it, our main purpose in all this is to put a lot of information in the place where it will do the most good—in your hands. These days it behooves us all to rustle our collective bustle if we wish our rather desirable *status* to remain *quo*. The editors think that some of the information and know-how collected here may show you where you can save some man-hours or produce a few extra tons of metal, which may soon count for much. Or possibly it's your idea, found on these pages by another mining man, which will be used to help dig a little more rock in a little bigger hurry.

Mining better and faster now could well be the most important objective in your career, because, beneath the pat little slogans about "our way of life" or "a free world," carefully fabricated in comfortable offices by manicured hands; beneath that stirring hogwash dispensed by spellbinding politicos, there's one important factor about a war—did you win or lose? You can taste the difference; it's not measured in abstract ideals.

In the cellar of a friend of ours there hangs a steel helmet, formerly the property of the Imperial Japanese Army. The lady of the house fills it with dirt and grows things in it. Our friend bumps his head on it, every third trip to the cellar. On such occasions, he is likely to employ very abusive language, but invariably it occurs to him how much more satisfactory it is for him to be bumping his head on that Japanese helmet, than to have some Japanese veteran somewhere in Nippon bumping *his* head on a Marine helmet. Brother, that's the difference between victory and defeat!

All of which is a back-door way of saying, let's mine rock while the mining is good.

» We probably should have left those last three paragraphs in the college dormitory along with the ticket stubs from the junior prom. Ordinarily we prefer to consider that for profound thinking we are in the same class with a friend named Max, from an office down the street.

Max and an associate were sharing a melancholy cup of tea in an empty cafeteria one afternoon. After a prolonged period of thoughtful silence, Max, staring broodingly into his tea, said, "You know, Sam, life is like a cup tea, yet."

Sensing the profound, Sam asked, "Why, Max—why is life like a cup tea?"

Max shrugged. "Who knows. Am I a philosopher?"

» As Jimmy Durante would put it, with gestures, "Everybody's tryin' to get inta de act." Well, a couple of months ago, E&MJ succeeded. The Act, in this case, was H.R.3336 before the Senate—specifically, "An act to suspend certain import taxes on copper."

E&MJ's role is covered in the last paragraph.

"In determining the average market price of electrolytic copper for each calendar month, the Tariff Commission is hereby authorized and directed to base its findings upon sources commonly resorted to by the buyers of copper in the usual channels of commerce, including, but not limited to, quotations of market price for electrolytic copper, in standard shapes and sizes, delivered Connecticut Valley, reported by the Engineering and Mining Journal's Metal and Mineral Markets."

» A not too reassuring note to people who eat salmon out of the Columbia River comes to us from the General Electric Co., which operates the Hanford Works out there for the Atomic Energy Commission. Says the release, *"One person would have to eat, at a single sitting, 100 lb. of Columbia River salmon caught just below the Hanford atomic energy works at Richland, Wash., to take into his body a noticeable amount of radioactive material resulting from operation of these works."*

The only question is: What do they mean by "noticeable?" We have a friend who, after driving his jalopy up the steps of the public library and wading in the bird bath in the public square, wondered on the following day if his intoxication was "noticeable." Seems to us the word "noticeable" should be pinned down before some one disintegrates after a fish dinner.

» We're told that whenever the head of a certain Government office has a boring but important document he doesn't want his staff to miss, he simply marks it "Secret." They all read it right away.

» Put away your lamp, Diogenes, we've found an honest woman for you. A while back we sent a small check for a contribution to a chap at the Kerr-Addison mine in Virginiatown, Ontario. The address we used must have been vague because we got the check back with the following letter:

"This letter was opened by mistake. It came to our box and as there are no other Kerrs around and our post office is Addison, it was a sort of mix-up. So am mailing it back to you as I notice it contains a cheque. Am sorry we opened it, but the postmaster didn't know where it belonged.

(signed) Mrs. Fred Kerr,
Addison, Ontario"

Thank you, Mrs. Fred.

» For the following report, we are indebted to *Natural Resources Notes*:

The only diamond mine in the U.S., one near Murfreesboro, Arkansas, has not operated for several years. The deposit is not now considered commercial, although since its discovery in 1906, it has produced about 48,000 diamonds—mostly industrial, but some of gem quality. The owners have now opened the property to any visitor who wants to try to find a diamond, reportedly the first time any diamond mine in the world has been so opened.

ENGINEERING AND MINING JOURNAL

Production for Defense

CONSIDERING what a small segment of either history or the globe has witnessed what we Americans accept as "freedom," it is remarkable that we could have come so close to forgetting that freedom is not guaranteed, but must be defended.

The setbacks we have experienced, the mistakes we have made, and the vacillations in our position have caused many observers, within and without, to wonder if luxury has made us so soft that we have lost the will to resist tyranny.

Those of us who know America well know that we can and will fight for freedom. We will work, and sacrifice our privileges, our property and our lives if necessary. The spirit is still at the core, even if somewhat obscured by the easy way of life we have enjoyed in our times. In the great drama of human experience the American people will not be found unmindful of their heritage or inattentive to their responsibility to the future when the hour of need arrives.

But the spirit to resist must be implemented. The four cornerstones of national strength, all equally important and absolutely essential, are inspired determination, armed might, industrial productivity, and an adequate supply of raw materials. Our job in mining is to produce, produce, produce, essential raw materials. Those who can contribute effectively to this end are more valuable doing so than in any other role.

We must find and develop new ore reserves, and recover everything possible from those we have.

We must end the stupid, destructive feud between labor organizations and management.

We must protect the manpower we have against both wrongly conceived draft policies and competition from other industries. This includes not only workmen but the precious technical talent so necessary to continued progress.

We must put our plants in tip-top shape.

We must catch up development work and build a backlog against the time of need.

We must develop new exploration methods.

We must stretch the work of our hands and brains further than ever before, by better machines, better methods, and better cooperation. Spurred on by new realization that liberty is more precious than luxury, we must be prepared to give what is necessary, not only for our children's future or to back up the lads in uniform, but to preserve the right to individual self-determination, without which nothing else in life has dignity or value.

Engineering and Mining Journal produces no minerals directly by its efforts. However, through a long history it has enjoyed the high privilege of helping a great, productive, essential industry do its job ever better and better. To further that purpose at a time when it is most needed, we dedicate this special offering toward the mining industry's PRODUCTION for DEFENSE.

New Exploration Methods Have a Great Future, but Need Support

A PROMINENT GEOPHYSICIST recently remarked to us that mining executives are not blameworthy in the support they have given to geophysical prospecting. "They will try," he said, "anything that seems promising."

This statement was not intended to be either ironical or epigrammatic, but it just about tells the story. Mining executives are quite willing to test out in their own properties the fruits of somebody else's blood, sweat, tears, and expensively won knowledge. But who, pray, is supposed to be expending all the time, money, and energy to assure the mining industry of a future? Does the hope of patent protection or large rewards through discovery promise to be sufficient? In a nutshell, No. The people who have the greatest mortgage on mining's future—the large companies—are waiting for someone else to do their job for them. Thus, the job of developing new techniques of exploration, be they geological, geophysical or geochemical, is proceeding at an inadequate pace.

Finances Needed

Quoting from recent correspondence: "Who is going to finance the research work necessary for the development of new geophysical techniques in mining? We have found a remarkable lack of interest, for one reason or another, amongst the mining companies in such research. The common attitude seems to be that they are quite willing to try any scheme, no matter whether it is on a sound technical basis or not, that is presented to them as an already successful method. They are not, however, willing to finance the development of new techniques. This susceptibility to 'promotional' geophysics has been responsible for much of the disappointment of the mining companies in the past."

The oil industry did and is doing otherwise. It spent real money and effort to develop new methods. The results speak for themselves. We know the opinion is widely held that the oil industry had a comparatively easy problem; an opinion, however, on which we disagree. We predict with confidence that when the mining industry has expended the energy on developing new methods that the oil industry has done, the results will be comparable.

A prominent mining geologist wrote us recently: "A first essential in any ore search investigation is a properly planned and adequate program where the necessary successive steps are undertaken progressively; old and new techniques should be analyzed, then used or discarded as deemed best. Few new ore discoveries have been made in the United States for several decades because very few adequate ore search programs have been undertaken during that period."

Nobody could view with understanding the progress that is being made in exploratory science and be fearful that new, effective, exploratory techniques will not be found. Geologists are proving every day the vital importance of structural controls in localizing mineralization. Good geology is making relatively few drill holes tell the stories that it formerly took vast sums to tell by drilling alone. Geologists are also proving that it pays to examine all available data carefully, including careful surface and structural mapping, and using what geophysical or geochemical methods seem feasible.

Geochemical Shadows

Geochemistry has produced truly interesting results from the analysis of vegetation, of surface drainage, of soils, and of drill cores or cuttings. Two broad types of analysis have both given promising results: First, analysis for traces of the mineral sought and, second, analysis for "tracer" elements, metallic or non-metallic partners in the mineralizing process which moved farther than the ore minerals, and give shallow evidence of mineralized zones or structural conditions. Analysis is done by ordinary quantitative methods, by indicators or by spectroscopy. It is interesting to note that in some instances geochemical work has given "shadows" of orebodies in overlying transported "cover" indicating that ways may be found of looking through overburden in the large areas where thin cover of desert wash or glacial drift masks the underlying rocks.

Half-way between the geochemical and geophysical sciences is the work being done in gamma-ray surveys, both from ground stations and from the air. This technique, well established in the search for outcrops of radioactive ores, has had its most interesting results in delineating halos of high values surrounding centers of abnormally low readings directly above underground oil pools. There is much disagreement over the explanation for such phenomena and some learned folk have plausible reasons why they cannot exist. Nevertheless, although the methods in use may still be imperfect and not wholly trustworthy, we have seen evidence from both air and ground surveys which convinces us that the results cannot be laughed off and will probably produce revolutionary changes in oil finding.

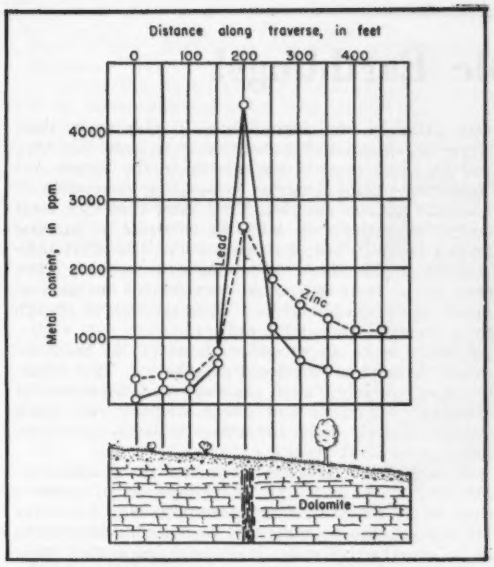
Gamma-ray surveys are also being made to map geological boundaries and to log formations in drill holes. Neutron-bombardment surveys are also being used in logging drill holes for formational changes and pore-occupying fluids. Up to the present time, gamma-ray work has contributed but little to the search for ordinary solid minerals, but we predict their growing value in formation mapping and possibly in detection of underlying deposits through cover, the latter being penetrable by radon, a volatile product of radioactivity.

Real Progress

When one turns to recent progress in the geophysical prospecting field, he is struck by the variety of developments and the twofold conviction that: (1) Meaningful progress is being made despite limited and sporadic financial support, and (2) A large amount of research and testing must be done to perfect techniques to the point where they are reasonably trustworthy.

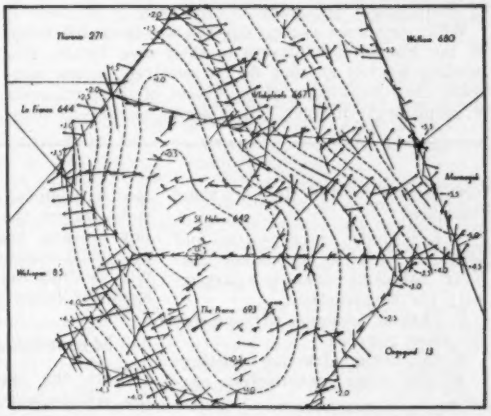
It should be worth the skeptic's time to consider the cases where geophysical methods have proved their worth so definitely that they

(*Continued on page 90*)



RELATIONSHIP between unnamed vein, Iowa County, Wisconsin, and geochemical anomaly in residual soil (Courtesy, U. S. Geol. Survey).

MUCH-IMPROVED sensitivity and quickness of response are products of continued research on the airborne magnetometer, shown here with head removed.



BIG-TIME PAYOFF resulted from this gravity survey, which preceded the drilling that opened up the Orange Free State gold development (Courtesy Geol. Soc. of South Africa).

Why Not Face The Future?

FOR THOSE MINING ORGANIZATIONS that believe they have a future—and a stake in it—why not a joint venture, capitalized at $25,000,000 and open to all comers, for three purposes: 1. To profit from exploration; 2. To undertake the application of new techniques in exploration; and 3. To foster research into new techniques.

The job will be done. It has to be done. If private enterprise fails to tackle it imaginatively, it will be done by Government to a greater extent than private enterprise will relish. The people will have the minerals they need and, if they think private enterprise is too slow or demands too much frosting on the cake. they will have their Government intervene.

Everyone acknowledges that new methods must be devised to find minerals. Those who are well-heeled and are not willing to develop the methods for the future are simply admitting their lack of faith either in the future or in their own ability to cope with it. In either case they automatically demonstrate their unfitness to have the directive power in large corporations which, nevertheless, will probably still be doing most of the mining a generation hence.

To do this job right, and on a scale which affords a reasonable chance of success, is a pretty large job. probably larger than any single company wants to undertake. Thus, our suggestion about a joint venture.

Is there a single company among the "Big 40" that would not profit by advancing the development of new exploration methods, even though none of the actual work might be done on its own property? But apart from their stake in development of new methods, the venture itself ought to pay its own way.

Such a venture does not have to be visionary. It can be run by the companies' own exploration men. It should not undertake to get into production when and if its "bets" win, but should sell or farm out its production problems and retain its own status as an exploration enterprise. If the mining companies can't furnish or find the men who can make such an organization succeed, their stockholders ought to be asking some fundamental questions.

The organization could operate in several ways: by participation with operating companies in joint projects, by wholly-owned projects, by contributions to research programs, and by its own research efforts.

When there is a job to be done that must be done, two courses are open. One is to proceed by main strength and awkwardness, stumblebum fashion, trusting that the mineral-needing public will eventually have to pay for the consequences of short-sighted management. The other is to face up to the job, plan for it, and go to work.

Those Incredible Earthlings!

Mineral Engineer's Report of a Flying Saucer Expedition to Earth

FELLOW MARTIANS:

The chief Sociologist's report contains details of the curious customs of the dominant inhabitants of Earth, their insatiable greed and their amazing combinations of good will and perversity; thus, I will confine my comments to my own special field.

As in the case of our own planet, the Earth contains a vast wealth of usable materials—in fact, is mainly composed of them. But the Earthlings have not progressed nearly as far as ourselves in using their more abundant materials. Curiously enough, although they still depend heavily on relatively scarce minerals, they prize them less than materials of much lesser consequence, such as vegetable and animal fibers, use them frequently for low-grade purposes, and make only lackadaisical efforts to reclaim them after use.

Such errors, however, are understandable, if not pardonable, when we realize the still primitive degree of development yet achieved on Earth.

What struck me as most curious was the indifference of the Earth's inhabitants to their own future. Depending heavily as they do on relatively scarce minerals, their knowledge of the extent of these minerals is surprisingly meager, but it seems to concern them very little. In fact, incredible as it may seem, their larger organizations devoted to mining know that they will be doing most of the mining in the future, but devote very little attention to assuring themselves of adequate minable reserves. They know that they must depend essentially on scientific methods of mineral finding in the future, but make very little effort individually or collectively to develop such methods. They even throw their depletable resources on markets at prices which discourage new developments, as though their reserves were unlimited.

I must make an exception, however, of their industry devoted to petroleum exploitation. This industry does actively foster progressive development of exploratory sciences and works cooperatively much more effectively than the other mineral industries, with concomitant results.

As a Martian, however, I do not favor either attempting to educate the Earthlings or to improve their lot by conquest. Every advantage they have thus far enjoyed has been devoted as much to destructive as to constructive ends. It is conceivable that their possession of sufficient scientific knowledge might impel them to try to disrupt sidereal equilibrium. I recommend continuation of the present policy of intermittent observation and holding forces in readiness to destroy them should they show signs of extending their perversity beyond their own spheroid and its inhospitable satellite.

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have become routine. Here are some examples:

1. Resistivity surveys to find depth of bedrock or shallow flat-lying lithologic changes, particularly for construction.
2. Shallow seismic surveys for the same purpose.
3. Salt dome refraction shooting.
4. Salt dome gravimetric surveys.
5. Resistivity logging of formations, porosity, and contained fluids.
6. Gamma-ray well logging for formation changes, and contained fluids.
7. Magnetic surveys for magnetic ores.
8. Magnetic surveys for large oil-field structures.
9. Magnetic surveys for certain lithologic boundaries such as of anorthosite masses.
10. Resistivity surveys for water supplies.
11. Gamma-ray surveying for radioactive outcrops.
12. Violet-ray prospecting for scheelite.
13. Oil-field seismic surveys for structure.

Then, in addition, there is a wealth of examples where geophysical prospecting has given less certain but helpful and promising results, where the function of geophysics has been to corroborate geological evidence or to reduce intensive study to limited areas. Consider the following:

Magnetometer Progress

Since the spectacular work in the Adirondacks during the war the airborne magnetometer has been used quite extensively and with increasing usefulness. A good deal of work has been done to improve sensitivity, orientation, and quickness of reaction of the instruments. The value of airborne methods for quick surveying of large areas, particularly undeveloped or poorly accessible areas, is being realized, as is the feasibility of carrying on photography and magnetic, electromagnetic and gamma-ray surveys simultaneously. Development of the numerous problems of instrumentation, flying technique and position finding is hampered, however, by lack of financial support, these methods being expensive to develop. In recent months the airborne magnetometer has led to discovery of important new iron deposits in eastern Pennsylvania and Ontario. It has been used effectively to define favorable areas for ilmenite and asbestos in Quebec, for iron ore in Venezuela and Labrador, for bauxite in Arkansas, and for manganese in Maine. Interesting results have been obtained indicating probable extensions of Minnesota iron ranges. Oil companies have made extensive use of the airborne magnetometer, particularly in examinations of large concessions in foreign territory. This record of progress indicates that this instrument will continue to be used even more widely by people who plan for the future.

When and by Whom?

This brings up two problems which call for attention. Are we allowing sufficient lead time in planning ore supplies for the future, and who is to do the research and development? All of us know that it usually takes many years between the time that attention is drawn to a promising area and actual production on an important scale. In general it seems as if the mining industry is hardly profiting from its own experience in time

lags between exploration and production.

As for the second problem, here is an interesting viewpoint from a correspondent: "More companies are establishing or increasing their geological departments all the time. Latterly, several mining companies are starting their own geophysical departments and it is likely that this tendency will expand just the way mining companies used to use geological consultants before it became a common practice to have their own geological staff. One element of geophysics may change this tendency. A geologist needs little more equipment than a Brunton compass; to be completely equipped for all types of geophysical exploration, however, requires a large amount of intricate, specialized and expensive equipment as well as a diversity of trained personnel. I would hazard a guess that some of the largest mining companies will find inordinately expensive the cost of keeping staff and equipment of their own capable of undertaking all types of geophysical exploration. If their exists a capable independent geophysical outfit, it should be preferable to employ them instead."

Other Methods

Turning to other airborne methods, promising results have been obtained in the few instances where tests have been made of electromagnetic surveying by induction. This method has checked known mineralization at Sudbury and Noranda, and has done effective dip-finding in Alberta, Saskatchewan and in the Gaspe Peninsula. It is regarded by competent observers as having great potentiality for the future, both in its own right and in combination with other methods.

Ground magnetic work is also being carried forward steadily, partly on independent work and partly for detailing and checking airborne results.

There has been a revival of interest in seismic work, already a routine feature of petroleum exploration. Efforts, with success in sight, are being made to "miniaturize" equipment to make it readily portable and to simplify and expedite results. It seems quite clear that seismic methods will soon enjoy equal recognition with resistivity methods in solving such problems as depth of overburden, position and dips of formations, and other geologic structures. It is even anticipated that methods now under development may adapt seismic techniques to airborne surveys.

GISH-ROONEY RESISTIVITY apparatus, being used for ground-water survey in Arizona, uses B batteries, a hand-turned commutator, ammeter, potentiometer, electrodes, and wires.

A method of directing radio waves horizontally so that through refraction they supplement each other rather than disperse, has been developed by a prominent geophysical consultant (E&MJ, May, 1949, p.81). Although the method has been used primarily in petroleum exploration, results obtained by one mining company are sufficiently interesting to warrant their continued work with the method.

Another mining company has been carrying forward a program of geophysical research and testing, chiefly electrical, and describes results as sufficiently interesting to justify continuation of the program.

A new method of interest is that of "induced polarization" developed by David Bleil of the Naval Ordnance Laboratory. This consists of passing a direct current through a metallic-type orebody as is done in resistivity work, then shutting off the current and recording the potential decay curve.

Fish or Cut Bait

Much more could be written on a myriad of detailed researches that are being carried forward by Government and private individuals, despite the lackadaisical support of the mining industry, toward improved instrumentation, new techniques and better interpretation. These details, however, are not appropriate here. They simply add confirming evidence to our conclusions, as follows:

1. Fair examination of progress being made in developing and testing new exploration methods thoroughly supports the conclusion that effective new exploratory methods can and will be developed.

2. Unless Government steps in and does the job for us (what Government is doing now is well worth while), the immense amount of work that is necessary will not be done in time to assure a steadily expanding supply of economic minerals until, for one reason or another, the mining industry increases its support of research, development and testing.

3. The necessity for doing the job is clear and the principal beneficiaries are identifiable. Why don't they face up to the future and, if their income is insufficient, refuse to liquidate their depletable assets except at prices which encourage replacement?

4. Methods now within the horizon may be ready to reward the imaginative and courageous immeasurably for picking them up and seeing them through on an adequate scale.

Grateful acknowledgment is made for valuable assistance from Messrs. Geo. M. Fowler, Oscar Jarrell, Henry Joesting and Sherwin F. Kelly.

PRODUCTION FOR DEFENSE

IN PROSPECT DRILLING:

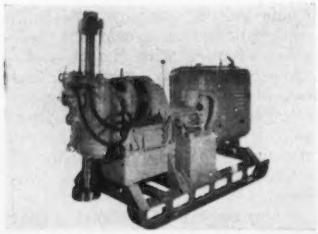
Emphasis on Mobility Keynotes Drill Design

HALF-TRACK MOUNTING gives desirable mobility and weight. This auger-type, hydraulic-feed drill is adapted to soft and semi-hard rocks.

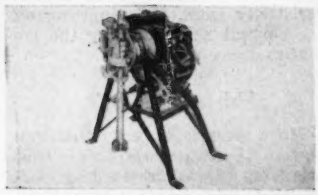
TRUCK-MOUNTED DRILL in use on Colorado Plateau takes 2⅛ in. core to depths of 2000 ft. Handles any kind of rotary bit.

ADAPTABILITY to any kind of rock and the long life of tungsten carbide bits makes percussion drills useful for hard-rock drilling to 100-ft. depth.

POWER TAKE-OFF on light truck enables easy moving and quick set-ups with auger-type, hydraulic-feed unit.



AUTOMATIC PRESSURE CONTROL and adaptability to any size of rods are features of this new drill.

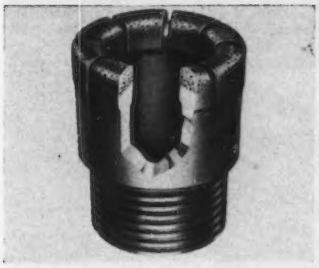


UNUSUAL PORTABILITY is feature of this 185-lb. diamond drill, capable of drilling to 200 ft. depth.

EXCELLENT PERFORMANCE is reported for this truck-mounted unit, which carries 700 gal. water.

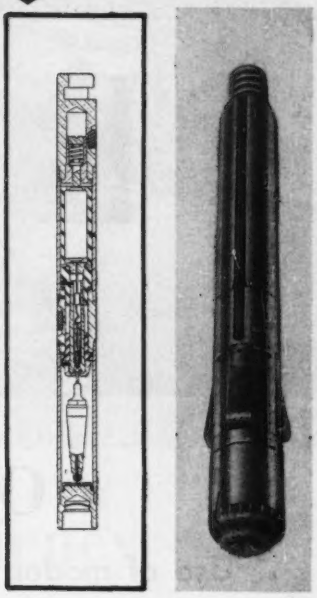
Bits are better and better:

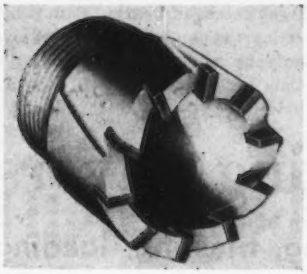
TUNGSTEN CARBIDE facings on teeth of drag bit make it able to handle tougher formations than formerly, with reasonable life.



INCREASED POPULARITY is evident for impregnated diamond bits, which are proving adaptable to tough drilling and scarcity of skilled runners.

DIRECTION AND INCLINATION are both obtainable, by this multi-shot surveying tool, available for rental.



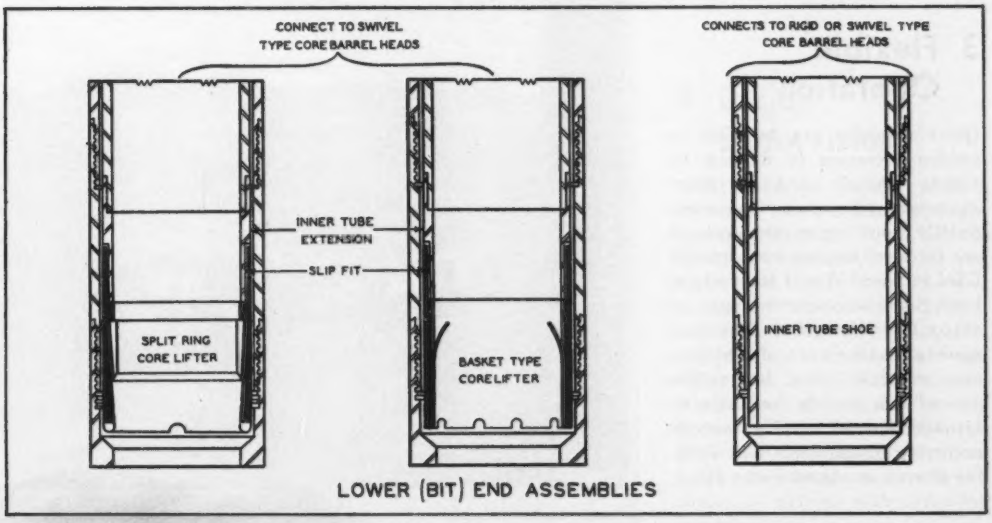


CORING BIT of tungsten carbide is adaptable to formations as hard as medium-hard limestone. Drag bit available where core not wanted.

TUNGSTEN CARBIDE teeth are making the oil field cone bit adaptable to moderately hard rock drilling of holes down to 3¾-in. diameter.

UNDERREAMING tool of new design is handy to get casing through overburden or below caving formations.

New core barrels are designed for maximum recovery.


CONNECT TO SWIVEL TYPE CORE BARREL HEADS
CONNECTS TO RIGID OR SWIVEL TYPE CORE BARREL HEADS
INNER TUBE EXTENSION
SLIP FIT
SPLIT RING CORE LIFTER
BASKET TYPE CORE LIFTER
INNER TUBE SHOE
LOWER (BIT) END ASSEMBLIES

CAREFUL ATTENTION to design of core barrels has resulted in great improvement of core recovery. Slip fit enables core lifter to get close to base of core. Universal inner and outer barrels are adaptable to basket and split-ring core lifters and to swivel or rigid connections between barrels, to meet various conditions.

1. Lower Costs

Mining in open pit can be cheapest of all extraction methods, when depth of overburden permits. This shows best when modern loading and transport equipment is applied to working deposits once thought too deep for surface mining. Left, a 25-cu. yd. dragline with a conveyor system for disposing of the spoil is stripping M. A. Hanna's Morton property on the Mesabi, after uncovering the iron ore in the South Agnew ground nearby. Both properties were formerly workable only by underground mining.

Open Pit Mining Favors

Use of modern equipment for drilling, blasting, loading

1. Lower costs. 2. Less labor.

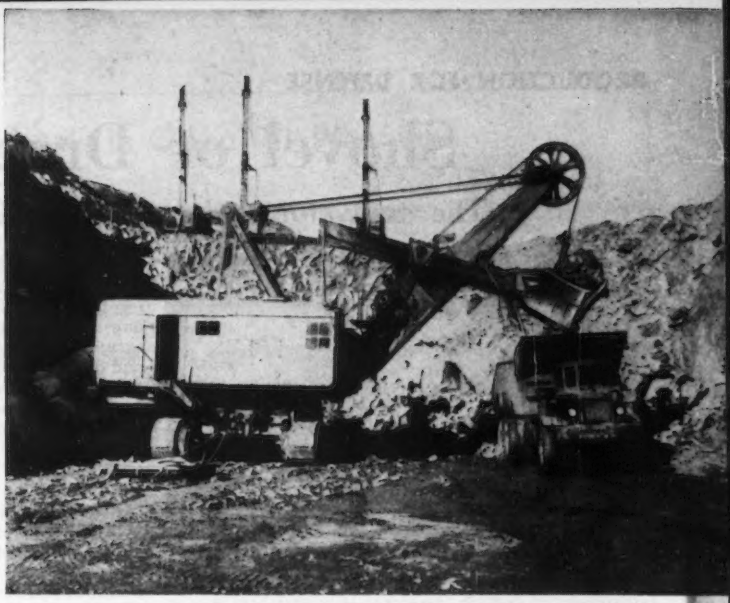
3. Flexible Operation

Quick response can be made to sudden increases in demand by adding shovels and accessory equipment, where reserves permit. Swiftly mounting requirements of ore for steel making were quickly filled in World War II from pits of Lake Superior operators, such as Oliver Iron Mining Co.'s Hull-Rust mine, a small corner of which is seen at right. Also, ore grades desired can readily be made by blending ores of varying analysis occurring in one deposit by shifting shovels or shovel crews about.

DEGREE OF PRODUCTION EFFICIENCY attained will turn

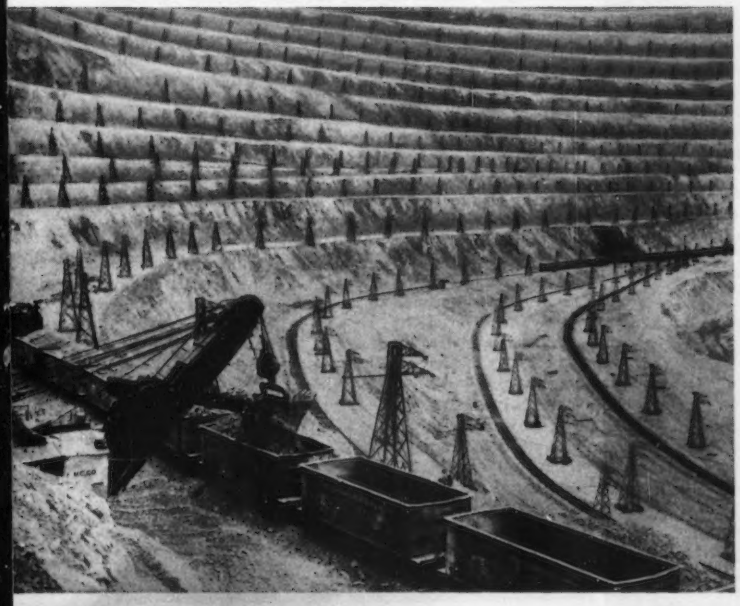
2. Less Labor

Fewer men per ton of output, in both skilled and common class, are required in an open pit than in an equivalent underground mine. One electric shovel, plus a small drilling and blasting crew, in International Nickel's Frood-Stobie surface mine (right) can produce 5,000 tons per operating day. This rate of production underground requires a payroll of 1,000 men, with a mining force working in 40 stopes. Surface mining provides a simpler task in respect to labor supply and management.



High Production Efficiency

and transport is a prime factor. Its big advantages are: 3. Flexible operation. 4. Easier supervision.



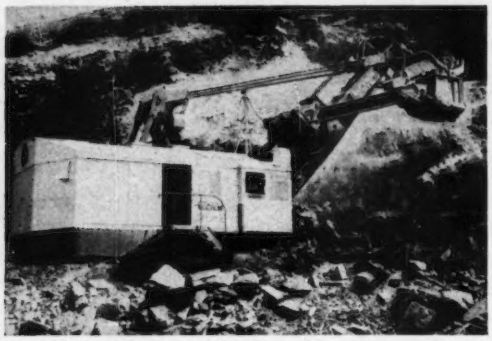
4. Easier Supervision

With production coming from a relatively small number of high-capacity digging and loading units, distributed about the pit, supervision can be simple as well as effective. Increasing use of two-way radio communication also, as in Kennecott's Utah Copper pit, shown at left, still further simplifies the task. Proper maintenance is facilitated in this way by keeping equipment operators in close touch with maintenance crews and shops, as well as with operating supervisors.

largely on the selection of the proper equipment for the job

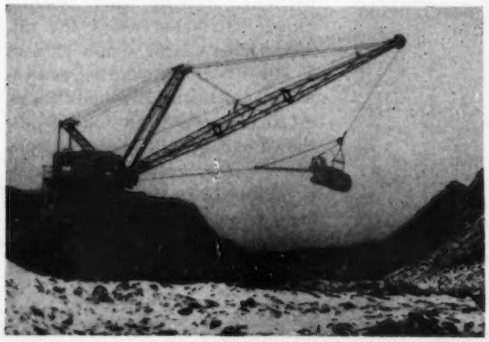
Shovel or Dragline?

The excavator is the open-pit's key machine



MODERN ELECTRIC SHOVEL, powerfully built and capable of big output in hard digging. Trend in dippers is to larger sizes, this one being rated at 7½ cu. yd.

STRIPPING SHOVELS, having boom and dipper stick of greater than standard length, can cast overburden at considerable distances from the machine.



THE DRAGLINE'S REACH fits it best for jobs where overburden or ore can be disposed of by casting. The machine works on surface instead of in the cut.

The Shovel. Size for size,[1] the shovel's producing capacity is greater than a dragline's. It is preferred for the more difficult digging and where material dug must be moved some distance from the pit. An exception is the stripping shovel, which has boom and dipper stick longer than standard and is used for casting to either side like a dragline.

All shovels are crawler-mounted. This makes for mobility and flexibility in the pit. Practically all are also full-revolving, making it easy to set large fragments aside for block shooting, and to clean up material from slides that occur behind the shovel. Trucks can also be spotted close to the shovel on either side.

In general, an excavator should be able to load steadily at the desired rate, and in a fast well-synchronized cycle, with minimum lost time and with accurate spotting of the dipper over car or truck. The dipper must be large enough and of such design that it can take its rated load quickly and dump it again with minimum spillage. Operating range must be sufficient for the necessary digging and dumping, and include enough vertical reach to permit loading into high trucks, as well as to lessen the number of cuts in benching.

Labor requirements on and around an excavator, power consumption and maintenance also depend to some extent on the type, size or quality, or all three, of the machine selected.

The Dragline. In much open-pit mining the material dug is cast alongside the cut, instead of being loaded into cars or trucks, or conveyor hopper. With longer boom reach than the shovel, the dragline can cast further. It also stands on the surface being excavated rather than in the cut where conditions are likely to be more difficult.

Most draglines are crawler-mounted. With this mounting the machine is rarely bigger than 6 cu. yd., save where it has been converted from an electric shovel, and so does not compete with the larger walking drag. The crawler mounting lends itself to mobility. The machine works close to the ground.

There are smaller crawler machines, powered by internal-combustion engines, for use where the material dug occurs in patches, requiring movement from one occurrence to another. The grades met are easily negotiated.

The larger draglines are of the walking type. This type is maneuverable, has lower bearing pressure and works with its base close to the ground. It is especially suited for soft or swampy ground.

The walking dragline is applicable where capacities of 5 to 6 cu. yd. or more are wanted, or boom lengths over 120 ft., or where the digging job is to be of long duration. This excavator requires a fairly large surface to move on and, where ground is uneven, may have to make its own road. Where movement is over a confined area or the material dug is deep so that the moves are infrequent, the walking type gives big production and lower first cost.

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[1] In preparing this section, the editors acknowledge assistance of various operators; also of Bucyrus-Erie Co., Marion Power Shovel Co., Harnischfeger Corp., Northwest Engineering Co., Osgood Co., Thew Shovel Co., and Baldwin-Lima-Hamilton Corp.; also the Caterpillar Tractor, R. G. LeTourneau and LaPlant-Choate companies.

Fundamentals in Open-Pit Planning

1. Engineering estimate.

Exploration drilling, geological study, sections and topographic mapping provide data on: (a) Overburden yardage, depth and disposition. (b) Ore tonnage and grade. (c) Shape of deposit.

2. Desired production rate.

On it depends the number of units of major equipment needed for breaking, loading and transport.

3. Stripping relative to production.

If stripping is to be complete before mining begins, or is to precede mining by a certain margin, it will bear on the equipment needed. If yardage is big, it may be cheaper to contract it than to provide more equipment than can be used later in mining.

4. Relation of size of orebody to desired production rate.

If both are large, the rate being, say, 2 million tons per year, 5- or 6-yd. shovels and fairly high banks will be favored.

5. Selection of equipment.

Equipment must be chosen for specific conditions. Experience is a valuable guide. The desired production rate (2) and the time element indicated in (3) must be considered.

6. Surface facilities.

Size of shops must be in proportion to number of units planned for stripping and production. The better the maintenance, the higher the availability of operating units and the lower the total number of units required for a given output rate.

7. Adequate drainage.

A good system of sumps and ditches is needed to keep pit water below operating levels and, on top, a system of ditches to keep water from the pit.

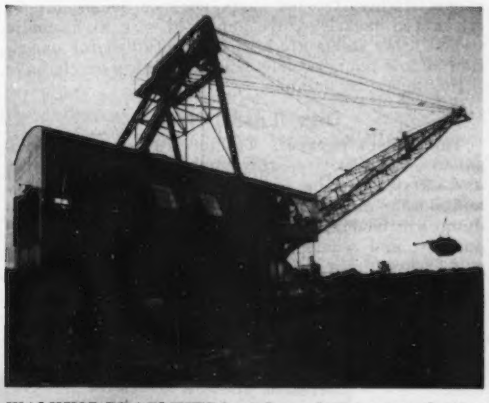
Case Studies. Minnesota Iron Country conditions have not favored wide-spread use of draglines: 1. On the Mesabi, overburden on large stripping jobs must be removed some distance, instead of being cast. 2. Ores and waste dug vary greatly. 3. Stripping yardage must be large to justify the use of draglines because the machine does not fit well into the ore mining that follows. 4. Use of the big draglines for mining would make it less flexible because they are less maneuverable.

Outstanding installations currently in Mesabi service have large yardages to handle. In three cases the drag has been tied to a portable screening plant feeding a long conveyor system used for waste disposal. See picture, p. 94. (Please turn page)

Largest Dragline?

Erection of a newly designed walking dragline with a 282-ft. boom and 20-cu. yd. bucket is nearing completion in Northamptonshire, England, where it will be used in mining ironstone by Stewarts & Lloyds Minerals Ltd., of Brigstock. This machine will be capable of handling up to 100 ft. of overburden. Its dumping radius will be 260 ft. Total weight will be 1600 tons.

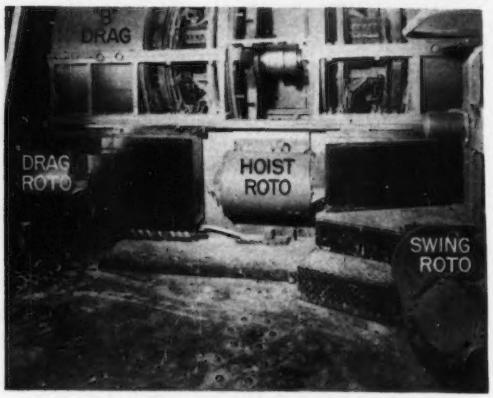
The boom is of an entirely new design, being constructed throughout of steel tubes. Height from ground level to boom head will be 175 ft.



WALKING DRAGLINES have base close to ground, exert lower bearing pressure, are suitable for soft terrain. Under right conditions they have big advantages (page 94).

A WALKING DRAGLINE SHOE close up. This type of excavator requires a fairly large surface to move on and, where ground is uneven, may have to make its own road.

DIESEL EXCAVATORS and the diesel-electric machine shown here operate independently of outside power supply. Latter also offers low-cost operation of electric drives.



ROTATING CONTROLS applied on large electric machines (here a 25-yd. dragline) give fast, smooth operation, cut maintenance. They are provided as standard on some larger shovels and draglines.

THIS AGILE MOTORIZED SCRAPER has many and diverse uses. Outstanding is its ability to dig its load quickly and to haul it at high rates of speed.

In contrast, extensive use is made of the dragline in all sizes up to 20-25 cu. yd. in the Florida pebble phosphate field, for both stripping and mining. Stripping there is now done largely by casting into the adjacent mined-out cut. In most cases, mining follows immediately, with the same machine.

What Power? Where adequate electric power and maintenance men are available and frequent long moves are unnecessary, the electric excavator with the Ward-Leonard system is ordinarily preferred to one that is diesel-powered. D.C. power has superior characteristics. Whereas diesel and gasoline units run at constant speed, the Ward-Leonard drive gives maximum torque at low speed and low torque at high speed for maximum efficiency and long equipment life. Over years the machine will operate at lower maintenance cost per cu. yd. than the diesel-driven excavator.

Better operation of the larger electric excavators is being obtained with a rotating type of control. Its use avoids electric surging, cuts maintenance of contactors, and gives smoother performance. It substitutes a small exciter generator for the magnetic contactor panels used. This generator's field is controlled through resistance steps from the shovel runner's master controller, and the exciter's varying output supplies the main generator's field. One builder is providing this control as standard on all machines of 6-cu. yd. capacity and larger. On smaller machines, its cost relative to total cost is too high to permit standard installation.

Another type of electrical control works on an induction principle, eliminating make-and-break contacts and improving response time. It handles the field-excitation currents direct.

Smaller shovels, however, often do have power controls. These are usually hydraulically or air-actuated, the latter being more used.

With electric power the cost of installing and maintaining secondary power lines is a drawback.

Diesel power is available in shovels up to 6-cu. yd. size and in walking draglines up to 12-cu. yd.

Fuel consumption per hour in diesel machines increases with size. Demand for diesel power is increasing in the 1-cu. yd. units. Those up to 3½ cu. yd. are largely diesel-powered. In the 4- to 5-cu. yd. diesel-electric shovel, diesel-power plant economy is combined with the low-cost electric operation.

Original cost of power plant, repair parts cost, and maintenance are higher for diesel power than for gasoline or electric power. Fuel supplies are becoming more accessible. Diesel fuel is cheaper than gasoline. Diesel power provides greater torque and can carry overloads for short periods, which the gasoline engine cannot do.

Gasoline power is not used ordinarily for excavators larger than ½ cu. yd.

Alloy Steels. These are being used in dippers, buckets and booms to increase capacity and working range. Highly stressed parts, such as booms, dipper sticks and back legs, are improved with high-tensile steels. Alloy steels are also being studied for operation at low temperatures where ordinary steels have little impact resistance.

Digs, Loads, Hauls

The Wheel Scraper. Tractor-drawn or self-propelled on rubber tires, this combination of excavator and carrier can be useful in digging gravel, clay and similar materials where yardage and distance to dump are moderate, boulders are small in size and number, and where the spoil cannot be cast. The rubber-tired unit works readily under off-the-road conditions of soft going and steep grades. Manufacturers' engineers believe the trend is to higher speeds and greater capacities. As a result the self-propelled models are multiplying. Where the tractor-drawn scraper is idle, the tractor can be put to many uses.

The Crawler Tractor. This machine has widespread and varied use in open-pit work, especially in cleaning up around the shovel.

Open-Pit Drilling and Blasting Must Serve the Shovel

These initial operations should be directed to getting lowest overall mining cost. Varied means for making blast holes available

OPEN-PIT DRILLING and blasting must be planned to give the best mining cost, with the proper regard for safety. These initial, inter-dependent operations are important in the mining cycle. In one instance, involving over 12,000 tons of rock and hard ore, they cost more than three times as much as loading and 29% more than haulage. Nevertheless they must serve the shovel, the key machine and the most expensive piece of equipment on the job. The work of loading must proceed at capacity.

Delays that occur in loading are usually from the following causes:

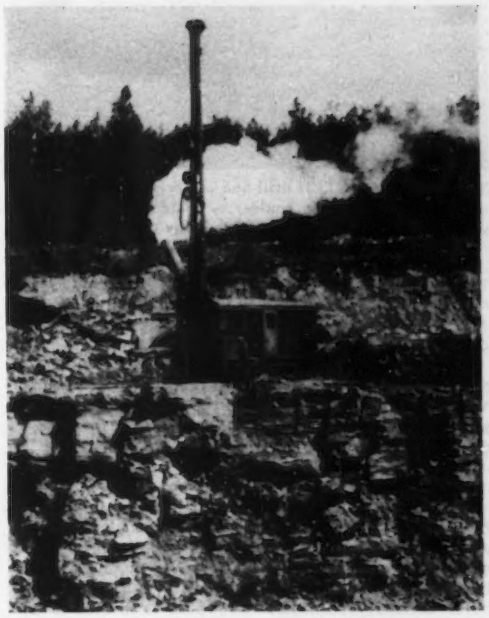
1. Big blocks from blasting, which must be sorted out and placed to one side where they can be broken up by block-holing or mud-capping.
2. Irregularities in the bank in front of the shovel due to excessive and irregular backbreak. Large masses may overhang the face and have to be brought down, either by the dipper or by men on the job, with possible risk for equipment and men.
3. High or irregular bottom caused by faulty pattern and improper loading of the holes.

What is wanted therefore is good fragmentation, with uniform crest and toe line and minimum backbreak. This will permit loading up to the shovel's maximum speed with minimum hard digging and consequent maximum production and low maintenance cost. R. M. Belliveau, general superintendent of Cleveland-Cliff's Mesabi Range mines, whose views are given in part, recommends a combination of closely spaced holes, fast powder, and deck-loading of the holes to yield the maximum amount of well-fragmented rock. In hard rock, for example, he suggests starting by spacing the holes 15 ft. apart on benches, 35 to 40 ft. high and 12 ft. from the crest. Shots so prepared will give the results desired with backbreak rarely going beyond the line of holes fired at a slope of more than one-half to one. The toe will be free from spurs and points. High bottom will be avoided by drilling 2 ft. or less below bench grade. The crest will be cleaned by the top deck load and the entire mass broken will drop 12 to 15 ft. below the new crest exposed.

Powder should be selected with regard to velocity, density, sensitivity, and water resistance, with the advice of the powder makers' field engineers. These men should be consulted before the holes are located rather than afterwards.

Aids to Better Blasting

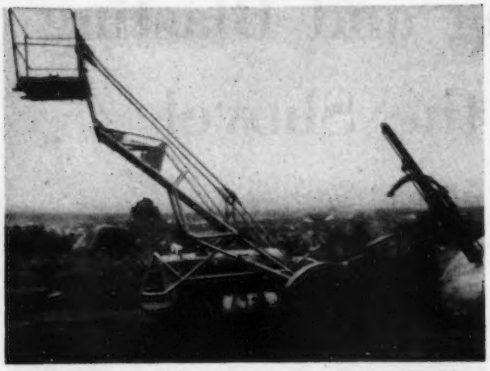
Short-Period Delays. Agreement is widespread among operators that, in general, better blasting results can be obtained by using milli-second, or split-second, delay blasting caps. Fragmentation is improved, shock lessened, powder saved. Their use gives more flexibility in timing the firing of individual charges. The underlying theory, according to D. M. McFarland of Atlas Powder Co., which pioneered this development, is that, "if the time of firing of explosive charges in adjacent drill holes is regulated to avoid their firing together, it seems that the shearing or cutting action from hole to hole can be retarded and thus the gases resulting from the detonation of the explosive charges can be held to work longer behind the burden."



THIS JET-PIERCING RIG recently made 156 ft. of 6½-in. hole in an 8-hr. shift in taconite on Erie Mining Co.'s ground near east end of the Mesabi Range. This was the highest daily footage to date made in taconite.

Time intervals that will give maximum fragmentation must be used. If the interval is too long (like that between first-period and second-period regular delay caps), there would be a geyser-like escape of gases from behind the burden and probably an excessive throw of rock. The drill-hole spacing, moreover, should be the maximum that may be used satisfactorily without leaving bottom between holes. It is logical to use the greatest time interval between the firing of adjacent holes that may be used without the cut-offs or geyser-like action mentioned, indicating too early release of burden.

Measurement of the time interval between the



TRACTOR-MOUNTED drill and compressor can be driven under own power from boulder to boulder about pit. With extension platform a boulder halfway up bank may be drilled with hand-held jackhammer.

detonation of adjacent holes in milli-seconds may also be accomplished by use of a motor driven switch making contact at predetermined intervals with circuits leading to instantaneous caps.

Breaking Boulders. For fragmenting a boulder satisfactorily to as great a degree and over a larger area than the shaped charge, so-called "Hi-Velocity" gelatin is available. This commercial explosive is easily handled.

The Drills

Churn Drills. This type of drilling is in general holding its own against varied, new competition. A prime advantage is the drill's relatively low initial cost. Nine-inch holes continue to prove more satisfactory in drilling and blasting results than the small holes formerly in vogue. Trend in hole size is upward, 12 in. being the present maximum. The ratio of tool-weight per inch of diameter can be increased to give faster penetration, according to Fred D. Vines. Also as hole size increases, fewer holes are required for the same total tonnage because the resultant larger powder capacity permits wider spacing. It must be borne in mind that fragments that are too large may hinder shovel loading.

When use of 9-in. holes was new, a change from 6-in. to 9-in. in a Michigan pit cut drilling cost per ton broken from 7.4 cents to 3.34 cents and operating cost per foot from $1.95 to $1.69.

Last year on the Mesabi a rock island underlain by ore was removed with churn drills. Footage totaled 9,129, comprising 189 9-in. holes. Volume to be blasted was 172,157 cu. yd. Powder used was 161,888 lb., a load ratio of 0.94 lb./cu. yd. Cubic yards broken per foot hole was 18.86. Primacord totaled 24,000 ft. Total value of explosives was $26,532. An electric timer was employed, also Primacord Booster delays. Stemming used was 210 cu. yd. (gravel).

Means for dressing the bigger bits mechanically have been provided. Question is raised by some as to the possibility of providing adequate shop facilities for sharpening the bits drilled in drilling hard taconite on a large scale. An alloy steel bit for churn drills has been developed for tough ground which increases the footage per sharpening. Experiments with carbide bits are under way.

Diesel-operated drills compare favorably with electric units, run 6000-7000 hr. without need of repair (at an Arizona mine), are flexible, and avoid the problem of feeding the electric cable.

Churn Drill vs. Diamond Drills. Competing in separate rock cuts (in the same formation) in the Steep Rock Iron Mines' diversion scheme, churn drills made 16,558 ft. of 7-in. hole and diamond drills 171,253 ft. of 1½-in. hole. According to C. H. Hopper, the diamond drilling compared favorably with the churn drilling in speed of operation, in absence of overbreak yardage (big in the churn-drill cut), and in giving a 10% lower total cost per pay yard.

Jet-Piercing. As footage and experience increases, confidence grows in the possibilities of this method for breaking taconite. The JPN-1 rig, on Erie Mining Co.'s ground, recently made 156 ft. of 6½-in. hole (31 ft. deep) in an 8-hr. shift, it is claimed. The best daily average in February was 112 ft. in 8 hr. The latest rig, JPN-3, now building for Reserve Mining Co., is designed to pierce a hole of 7½-in. minimum diameter to 45 ft. depth. Cheaper oxygen and lower charges in general will improve jet-piercing's competitive position. Fuel consumed (kerosene) is reported to be about 22 lb. per foot of hole. (See p. 99).

The Rotary Drill. The mobile rotary drill is already doing well in various materials. Joy's Champion "rotary air-blast" drill is being used in limestone, dolomite, gypsum and magnesite, also most recently in Utah iron ore. Tests indicate that it is adaptable to most open-cut drilling conditions. The rotary air-blast principle, said to be new in blast-hole work, instantaneously removes all cuttings. A rate of penetration of 30-40 ft. per hour with 7⅜-in. hole is claimed for sandstone. In magnesite and gypsum the drill is said to be giving 20 to 40 ft. per hour with a 6¼-in. hole.

An experimental rotary drill, built by Mechanical Miner Co., Chicago, to evaluate certain theories, has been under test for months. Average drilling time for a 9-in. hole 60 ft. deep is stated to be about 30 minutes, including time for lengthening the stem.

Piston-Driven Vertical Drill. The original Quarrymaster, introduced three years ago with a 6½-in. bore and 10-in. stroke, has been modified to have an 8-in. bore x 11-in. stroke. Two compressors, each 412 cmf at 130 psi, give 125 lb. at the drill. A 50% increase in production (feet of hole) is said to have resulted. Advantages claimed for this type of drill are: High speed; ability to drill any material; drills entirely dry; size of hole plus speed permits conservative pattern giving good fragmentation; use of carbide-tipped bits eliminates the blacksmith shop with the labor involved.

The Wagon Drill. This machine drills 2- to 3-in. holes with carbide bits, a length of 20 ft. being the approximate economic limit. Its place is primarily in work on shallow cuts. A notable exception is at Bingham, Utah.

A mechanized type of wagon drill is LeRoi's Tractair Mobildrill, shown above in a cut drilling a boulder in a Mesabi pit. The boom-mounted drill and the 105-cmf compressor are mounted on a 35-hp. tractor and may be driven to the job. It drills at any angle, using carbide bits.

For Auger Drilling. For large-diameter horizontal holes the McCarthy rock-boring machine has proved of value. Its use at a small eastern Mesabi pit with a 6-in. coal auger and a 6½-in. carbide-tipped three-pronged auger bit broke up the soft ore bed and the overlying hard taconite capping, so that the latter could be sorted out by the shovel. A vertical type is also made.

Truck and Conveyor Transport Presses Locomotive Haulage Hard

Rail equipment is still in picture for big orebodies, large tonnages, long hauls. Scrapers also find many uses.

SELECTION OF EFFICIENT transport equipment for a given open-pit stripping and mining project involves consideration of rail haulage, trucks and conveyors, as well as the various forms of scrapers. The size of the units chosen, for whatever the scheme adopted, will usually be in keeping with the size of the digging unit and the area of the pit. The latter controls the maneuverability of the equipment.

For all except the big operation, rail haulage may be ruled out unless the equipment is on hand or readily available and the first cost largely written off. In small pits the ore tied up in track benches would be too great a proportion of the total. Where conditions are favorable, however, rail haulage can give extremely low costs per ton or cubic yard.

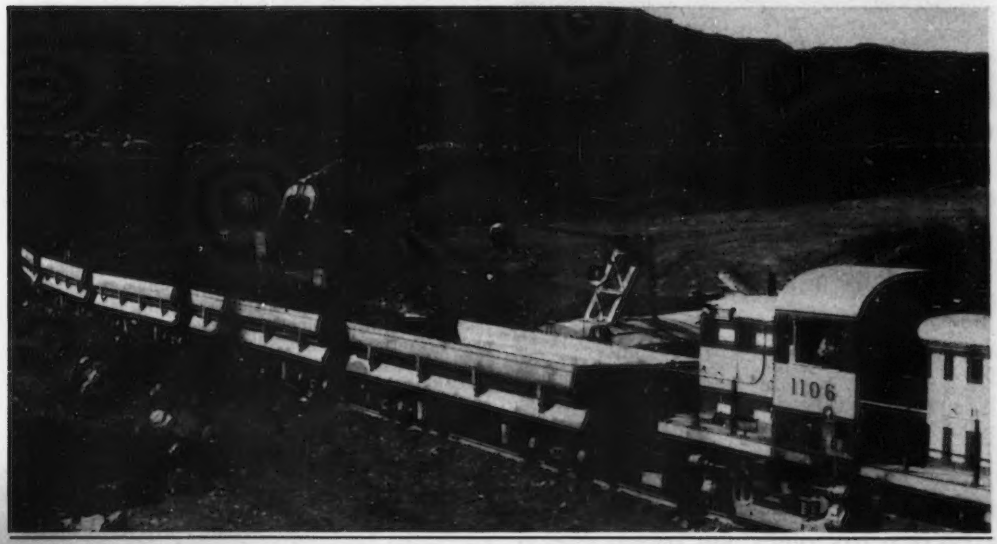
DIESEL-ELECTRIC LOCOMOTIVES, like the 1500-hp unit in the big iron ore pit on the Mesabi Range shown in Photo 1, are rapidly replacing older steam units. They are independent of a power line. Immediate result of replacement is lower operating costs. Fuel, labor, and maintenance expense is less. Engine shown can handle train of 8 of these 30-cu. yd. (60 ton) air-operated side-dump cars on a normal 3% grade. Train will dump ore loaded by the 6-yd. electric shovel into crusher pocket for processing before shipment. The newer cars have anti-friction bearings. (Photo by courtesy of U.S. Steel Corp.)

ELECTRIC LOCOMOTIVES (not shown) powered from overhead wire still serve for haulage in Nevada Consolidated's Chino copper pit, New Mexico; in the Chuquicamata copper mine in Chile; and in various other large open-cut metal mines. An electric locomotive replacing a steam unit of the same weight can haul 1.8 times as much ore, requires half as much maintenance.

IN CONTRAST TO SUCH BIG TONNAGE OPERATIONS are the many smaller jobs where wheel scrapers (see page 98) can fit in. Tractor-drawn or self-powered, these can be used for moving dirt to expose rock that must be stripped when opening a new pit, or for shifting haul roads and banks of overburden, or for miscellaneous odd-lot stripping. With this composite machine, which hauls what it digs and loads, the character of the ground must be considered. Boulders may make its use impossible.

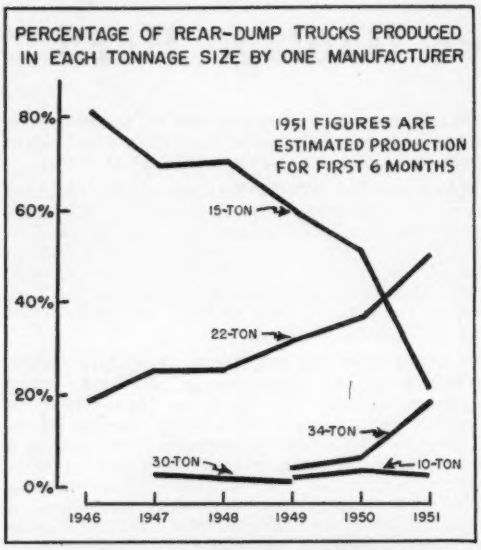
The scraper's operating cycle is important. Loading time, dumping time and time for shifting and turning may be cut by using a pusher or puller tractor. A rooter will help if ground is hard. Conditioning of surface of road and dump will improve the cycle, especially for the more maneuverable rubber-mounted, self-propelled unit. The latter's speed ranges up to 25 mph, compared with a top speed of 7.5 mph for the tractor-drawn type.

1. RAIL HAULAGE gives low costs under favorable conditions.



TRUCK AND CONVEYOR TRANSPORT has best solution for most haulage problems

Bigger, Better Trucks Promise Lower Costs



2. THE 22-TON TRUCK, such as the one loading, is yielding slowly to larger units.

3. Use of 34-TON TRUCK, here dumping waste at mine in Arizona, cuts costs.

AS THE SIZE OF HEAVY-DUTY TRUCKS INCREASES, the per-ton cost of labor and maintenance declines. The improved and larger models offer a chance of better operation. Capacity of trucks is trending upward. This is shown by the adjacent graph for one large manufacturer's 5-yr. output of **rear-dump units,** the type still most widely used. As production of the familiar 15-ton model has dropped, that of the 22-ton and 30-34-ton sizes has been rising to replace it. Looking ahead, at least two truck manufacturers are studying the possibilities of a 50-ton truck which will cary the load "on its back." Improved methods of building pit roads would be required for such a heavy unit.

Already more than half of the open-cut ore mined in Minnesota is moved in trucks, and a large part of the overburden. The truck's maneuverability and flexibility for hauling ore and overburden are largely responsible for this widening adoption. The change has helped operators economize. A 22-ton unit being loaded by a 5-yd. shovel is shown in Photo 2.

Maximum truck capacity in freezing weather, when ore fines tend to build up in the boxes, is maintained by heating the body of the truck. This is done by turning the engine exhaust into the truck lining where angle-iron has replaced the wood sandwich, through connecting pipe in body.

In estimating the amount of equipment for a job, about 20% of the trucks behind the shovels must be figured as spares.

If the pit under study is small, trucks must be used because of the grades. While 7% is preferable, one can go to 15-20% for short distances.

BIGGER HORSEPOWERS are required for the bigger trucks. Except for one two-engine model, a leading truck manufacturer is using motors ranging from 125 to 300 hp. against 125 to 286 hp. previously, and total horsepower ratings of 380 to 400 for twin-engine, rear-dump, bottom-dump, and scraper units. Some 34-ton rear-dump models have been equipped with a 400-hp .engine of prominent make, but at recent date this model was not in standard production. Photo 3 shows a 34-ton truck dumping waste in a copper pit in Arizona. It is powered by two 2-cycle diesel engines with a combined rated horsepower of 380 at 1900 rpm.

ENGINE LIFE up to the point where the engine is rebuilt is commonly 5,000 to 6,000 hours, depending on the make. Truck life is now 20,000 hours.

USE OF THE TORQUE CONVERTER will improve engine operation and give other benefits. The converter serves to multiply the torque, or twisting force, of the engine's output shaft. In effect, it offers an infinite number of speeds in transmitting power to the shaft, as compared with mechanical transmissions which are limited to a certain number of definite gear ratios.

The converter largely eliminates the human element in driving. Faulty shifting and clutching caused by the variation in drivers is hard on the truck and increases the maintenance cost.

As listed by Oliver Iron Mining Co.'s C. R. Burton (Salt Lake City meeting of Mining Congress, Aug. 1950), the benefits of the torque converter comprise: Less maintenance of engines, clutches, transmissions, drive lines, differentials, and drive axles; less

skill required on part of driver; driver's fatigue reduced; truck production increased due to less shifting and improved maneuverability; and the possibility of using engines of less horsepower in present trucks.

(Burton also points out the possibilities of the gas turbine in that it has the desirable features of a fluid coupling, surh as infinitely variable transmission, high starting torque and rapid acceleration.)

Converters of several different makes are already in service on some 50 or more heavy-duty trucks in the Minnesota area. With Euclid it is standard equipment on 34-ton trucks, optional on other sizes.

The torque converter as applied to trucks will be discussed at length in **E&MJ** in an early issue.

FASTER, EASIER TRAVEL results when truck drive axles are spring-mounted. Greater speed improves the operating cycle. Easier riding cuts shock and maintenance. Spring-mounted models, like that in Photo 2, have definitely proved their ability to maintain higher travel speeds on both loaded and return trips where roads and length of haul permit utilization of the greater speed. Photo 4 gives a close-up of the spring-mounting on the truck in Photo 2. The method permits the spring to float free (there are no spring eyes or shackle bolts), practically eliminates the spring breakage normally caused by twisting of the leaves.

DRIVER COMFORT is important. Indirectly it concerns labor turnover, operating cost and maintenance, as well as safety. Steps to provide comfort in trucks include provision of hydraulic boosters in the steering system, air-operated clutches and improved seats, to reduce driver fatigue. All these, together with spring-mounted front and drive axles used in the truck shown in Photo 2, make the vehicle easier to handle on tough hauls.

TRACTOR-TRAILER trucks, of bottom or side-dump type, have proved themselves economical and good producers under the right conditions. They have an opportunity as size of loadings increase. Photo 5 shows a unit with an Easton side-dump trailer. The all-welded body is reinforced throughout with box sections, giving strong construction. It dumps to either side and may be reversed end to end to prevent excess wear on one side.

SIDE-DUMPING TRAILERS, delivering to either side by use of twin air cylinders and with a down-folding door, are shown in Photo 6.

THE BOTTOM-DUMP WAGON in Photo 7 is controlled hydraulically. As tie jacks on the sides retract, the inner section of each double-hinge door folds down to meet a stop and the outer section is drawn up alongside the box. Ground clearance obtained is 20½ in., minimizing the chance of damage should the wagon be turned while dumping. Reversal of the jack action positively closes the doors which are locked by a linkage at each end of the box.

BETTER HAUL ROADS out of the pit are being made by all mining companies that employ heavy-duty trucks for transport, as trucks and the loads they carry grow in weight. The money so spent insures longer life for trucks and tires. In some cases the road material found within the pit will be inadequate for making the road required for the biggest haulage units, existing and planned. Equipment for building and maintaining roads is vital to the job. Photo 8 shows a road grader in an Iron Country pit

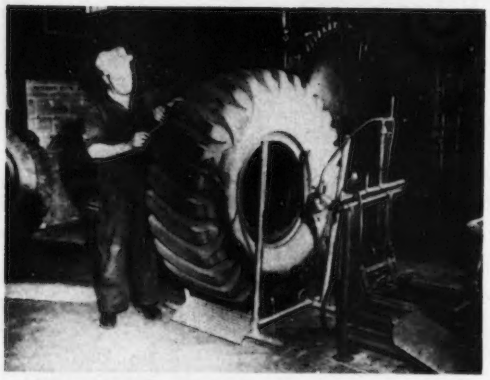
4. SPRING-MOUNTING of drive axles gives easier riding for both truck and driver.

5. SIDE-DUMP TRACTOR-TRAILER, here shown with pan-type body, can dump without turning.

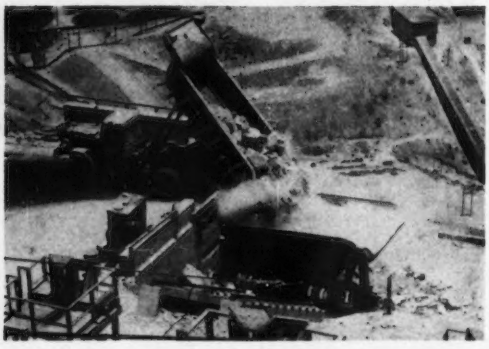
6. TWO SIDE-DUMPING TRAILERS in tandem require one driver, cut labor cost.

7. BOTTOM-DUMP WAGON has ample ground clearance, avoids injuring doors when turning.

8. ROAD BUILDING and maintenance are vital matters for heavy-duty trucking.



9. TRUCK TIRES can be repaired quickly by manufacturers at nearby points.



10. USE OF SKIP HOIST, in this case for lowering, avoids steep haul by trucks to crusher.

at work keeping grades and turns in the road passable.

TIRES are the largest single cost item involved in the operation of heavy-duty trucks. On the Mesabi the average large tire is of 1800 x 24 size, costing about $1500 each. A 6-wheel unit would have four of these on the rear end and two 1400 x 24 on the front. For repairing tires, the current trend is away from the mining company's own repair shop. In general, tire manufacturers are maintaining adequate facilities for the purpose within a convenient distance of the mining area.

Better Maintenance Helps Cut Trucking Cost

Average cost of hauling a long ton of ore and waste by truck was cut 24.9%, or from 11.59 cents in 1948 to 8.7 cents in 1949 by National Lead Co. at its open-cut, iron-titanium mine, Tahawus, N. Y., according to U. S. Bureau of Mines, I.C. 7854. The trucks included 14 of 15-ton capacity and 3 of 22-ton size, all Euclid rear-dump units powered by Cummins diesel engines. Reasons given for the reduction included:

1. An increase of 20.3% in haulage efficiency from 1948 to 1949.

2. Better maintenance of mine roads.

3. Creation of stockpile near crusher.

4. Reduced truck maintenance.

5. A reduction in operating time lost due to equipment repairs.

6. Low labor turnover and reduced maintenance with experienced drivers.

All trucks had tachographs to aid in the study. On the chart were recorded the exact total time the truck was in motion, the engine rpm's at all times during day, and total engine rpm's.

A Central Repair Shop for Maintenance

To handle the repair work resulting from possession of a fleet of 179 heavy-duty trucks and whatever may develop from 24 additional trucks just acquired, an Iron Country operator maintains a centrally located repair shop. This shop serves a group of mines scattered over 40 miles of the Mesabi Range. Of the 179 trucks 136 are 20-ton and 43 are 30-ton. Forty-one have 2 engines, each totaling 380-400 hp.

Besides the central shop, there is a shop at each mine at which engine and other replacements and daily truck inspections are made.

The work at the central shop consists of repairing engines, transmissions, rear ends, torque converters and other truck components. If an engine fails, a spare that has already been repaired is put in at the local shop and the truck returned to active duty with minimum lost time.

One spare is kept on hand for every 15 engines. The same ratio is maintained for the other components. Fifty-two of the 179 trucks have torque converters. Each double-engine truck has two factory-installed converters and two transmissions. In general an effort is made to increase availability by making parts interchangeable.

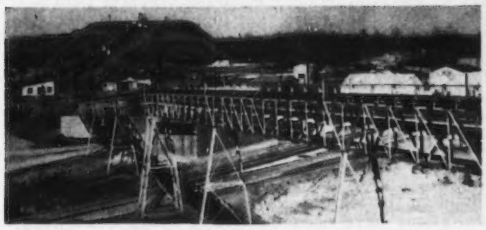
Trucks are checked daily for adjustment of brakes, clutch and steering gear, and for loose bolts and nuts, leaks of air, fuel and hydraulic. A more detailed inspection is made monthly.

A rather loose maintenance schedule is kept. Transmissions, clutches, rear ends and brakes are run to full life, but there is no tendency to run the engine to destruction.

Engine life has been increased by the inspection program. The objective sought is 6,000 hours between major overhauls where the engine is taken completely apart.

Belt Conveyors for Low-Cost Continuous Transport

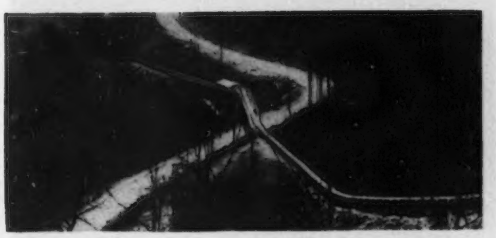
Basic problems the same, whether application is on surface, underground, in beneficiation plant or smelter



CAPACITY RANGE is broad. Tonnage transported depends on belt speed, belt width and weight of material. Economy is greatest when narrowest advisable belt is operated at highest permissible speed. System at National Lead's Magnet Cove barite mine and mill, here shown, handles 935 tons per hour.

RANGE OF MATERIALS that can be handled is wide—light or heavy, lump or fine, corrosive or abrasive. Here a double-wing stacker of Robins-Messiter system is blending iron ore to be reclaimed subsequently by the equipment provided for this purpose, for the furnaces of the Colorado Fuel & Iron Co. at Pueblo.

DISTANCE CONVEYED has no limit. Over 110 miles has been proposed. Long single flights are possible with high-tension belts. Greater distances can be spanned with series of belts in tandem. Photo shows start of 7-mile 36-in. conveyor line for delivering sand and gravel to Bull Shoals dam site. Twenty-one flights are moved at 525 fpm.

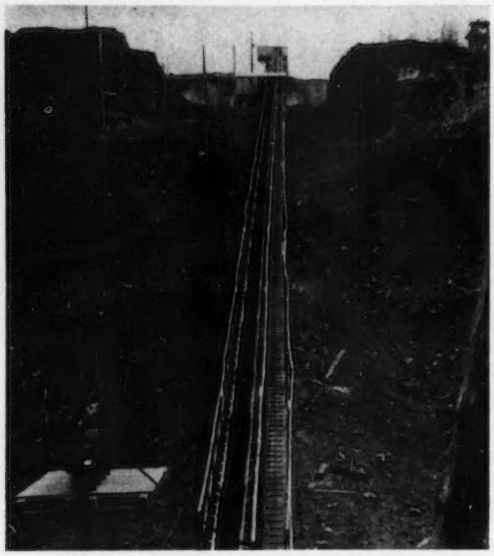


ADAPTABLE TO ANY PROFILE, surface or underground, a conveyor line can follow horizontal, ascending or descending paths, with grades up to 30%, limited only by angle at which material slides or rolls. Horizontal direction can be changed by aligning tandem conveyors at desired angle. Blue Diamond Coal Co.'s waste system is shown.

POWER CONSUMPTION is low, power factor uniform. There are no peak loads. On declining conveyors power can be generated and put back into lines. Edna Coal Co.'s 3-section line (shown) in Colorado lowers coal vertically 700 ft. in 2,462-ft. length. By-product electric energy derived by this means is used in preparation plant.

LOW HEAD ROOM required and smooth, silent, continuous operation favor use underground. Delays for spotting cars for loading are avoided. Dust problem is smaller, noise lessened, personnel fatigue and irritability are reduced. Photo shows conveyor under Miami Copper caving block.

IN SUMMARY, while capital investment costs are relatively high for short, low-capacity belt-conveyor installations and the conveyor lacks loading and discharge flexibility, it can be used wherever the degree of incline permits and material handled is not too sticky, too big or otherwise destructive. A conveyor has long prospective life. ➡



SPECIAL COTTON-NYLON fabric is used in this belt

Better Costs With High-Strength Belting

HIGH-STRENGTH CONVEYOR BELTING has made new achievements possible in transportation. By the term is meant belting whose carcass is composed of a material that has high tensile strength. Such materials that are being used today in belting are **cotton cords, rayon cords** and **steel cords;** also fabrics combining **specially-treated long-staple cotton with nylon.**

With such belting, conveyors can be constructed with long distances between head and tail pulleys, high lifts or declines, and greater tonnages can be handled. With long-center conveyors, fewer transfer points are required and much saving is effected in the cost of handling material. Most of the degradation of material handled occurs at transfer points. It is at these points also that belts are most likely to be damaged. Men stationed at the points are also eliminated, giving a saving in labor costs. Use of one long conveyor in place of several smaller ones also reduces the number of terminal pulleys, motors, speed reducers, couplings, etc. This cuts the initial expense of the installation.

Most high-tension belts have been installed in coal fields, but other mining has its share. Several can be found on the Mesabi. In the last few years these installations have been increasing rapidly, according to U. S. Rubber engineers.

OPEN-PIT CONVEYOR a link in ore-transport chain.

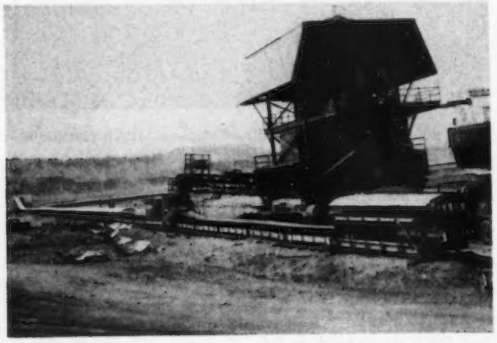
Splice for Steel-Cable Belts

THE MOST PRACTICAL SPLICE for the wide conveyor belt that is reinforced with many small steel cables, according to Goodyear Tire & Rubber Co., is an adaptation it has made of the splice used for single-layer cotton-cord belts. The steel cords themselves are not joined. Instead, the tension in one cord end is transferred to an adjacent group of cords through a shear consisting of a thin layer of rubber compound, and transferred back again by the same method to the original cord in an area farther along the belt. Each of the cords in the transfer group is handled in the same way at a separate zone in the splice.

All the cord ends are thus dispersed through the region of the splice in a calculated manner. The extent of this dispersal determines the strength of the splice. This splice has been used on one of the belts installed by the Chicago, Wilmington & Franklin Coal Co.

A LINK IN THE CHAIN, the conveyor line combines with highly mobile gathering units, such as heavy-duty trucks, to give continuous flow of ore from pit to surface. This enables trucks to remain in pit where they work at maximum efficiency. In Oliver Iron Mining Co.'s Gross-Marble pit, shown at left (middle), 30-ton trucks deliver ore to conveyor which hauls it over 1,000 ft. to surface, traveling at more than 500 fpm. Photograph by courtesy of the United States Steel Corporation.

STRIPPING CONVEYOR'S initial section, which takes its load from excavator (off picture to right) via portable screening plant, must be capable of being shifted as digging advances. This section delivers to permanent conveyor line in distance for transport to dump.



PORTABILITY is essential in stripping conveyor

Belts and Shakers vs. Trolleys

COMPARISON OF OPERATING RESULTS obtained at a Michigan Iron Country mine with a 36-in. belt-conveyor system fed by shaker conveyors on one level and a trolley-haulage system on another was favorable to the former. As reported in ME, April, 1951, the belt system took 0.12 kwh per ton against 0.42 kwh for the trolleys and gave correspondingly lower transportation costs. Fewer men were required.

Proper Belt Maintenance Essential

MAINTENANCE must be preventive in kind if the belt conveyor is to run continuously. It involves inspection, lubrication and repair. Idlers, lead and tail pulleys, and the drive, as well as the belt itself, must be included. Periodic inspection will show up cuts or snags in the belt cover, gouges and breaks in the carcass. When such damage is noted, suitable emergency repairs must be made to keep the entire belt from deteriorating. This is particularly important when the belt is exposed to moisture, or carries a mixture of lumps or fines.

Serviceable repairs can be made right on the job without special equipment. Various repair materials, available in kit form, obviate the need of vulcanizing equipment. Purchase of such equipment, however, is justified where the belt footage is large. It may be had at reasonable cost and of proper design. Such repairs are more lasting, come closer to restoring the belt to its original condition than any other method.

Where major accidents happen, such as carcass breaks or extensive tearing, which call for replacement of portions of the plies, vulcanizing equipment is essential. Its use soon becomes routine to the properly instructed mechanic. Many companies keep a well-equipped vulcanizing crew on the job.

Avoid Conveyor Shutdown

SAVINGS IN COSTS of installation and maintenance of heavy belt conveyors are claimed through use of a new conveyor drive developed by National Iron Co., Duluth. The new drive uses an overhung driving pulley, eliminating conventional head shaft and bearings, as well as the low-speed coupling or chain drive. This cuts out the maintenance on the bearings and coupling. The latter has been one of the major sources of belt-conveyor shutdowns. The design uses a speed reducer specially built by Westinghouse. The first overhung conveyor using this drive has been installed on the Mesabi range at a net saving of over $8,000 in installation cost. Photo at right.

Store Belting Properly

CARE IN STORAGE and handling of conveyor belt will reduce damage and abuse. In turn, this will give longer belt life in operation. Improper storage and handling, on surface and underground, can cause edge wear, cover cuts and gouges, carcass ruptures and deterioration of fabric plies.

Wherever possible, belts should be stored in a building at a cool, constant temperature, protected from direct sunlight. The rolls should be stored upright, axis horizontal, and kept in shipping crates.

Underground, it is often necessary to store rolls of belt on their sides. In such cases, the belt edges should be painted with a rubber cement to minimize the effects of edge abrasion. The belt should be stored on a circular plate and moved on it when necessary.

THIS SHAKER was used in a Southwestern copper stope

NEW OVERHUNG CONVEYOR DRIVE cuts costs

Boost Continuous Mining

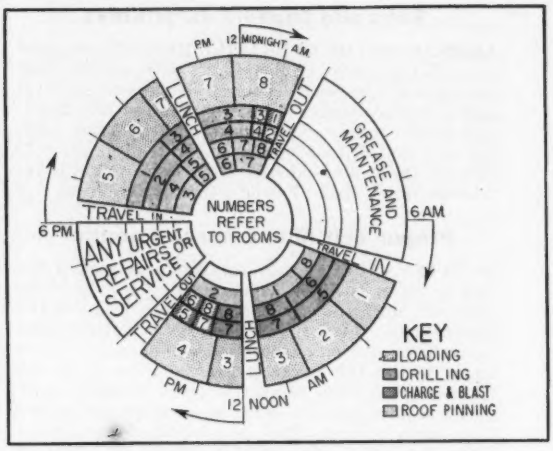
NEW CONVEYOR DEVELOPMENTS. To provide continuous transportation behind the Colmol continuous coal mining machine, a new intermediate conveyor transportation unit, or conveyor train, called the "Molveyor" has been devised by developers of the Colmol in conjunction with Jeffrey Mfg. Co. This machine takes the mined product from the Colmol in a continuous stream and, by means of a swing boom on the discharge end, places it on the mother conveyor or other transportation unit to be taken out of the mine. (**Coal Age**, May 1951, p. 77-79.)

Another development undertaken by other interests to solve the problem of continuous room conveying consists of a strip of stainless steel 36 in. wide and 1/32 in. thick, which can be wound on a spool in a coil as small as 20 in. in diameter. When uncoiled, this has been used as a shaking pan line for distances up to 600 ft., the end being mounted on crawlers. The coil is mounted on slides and given a shaking motion by a standard shaker drive. (**Coal Age**, April, 1951.)

In preparing this section, the editors acknowledge assistance of operators, also of U. S. Rubber Co., Hewitt Robins, Inc., Raybestos-Manhattan, Inc., B. F. Goodrich, Goodyear Tire & Rubber Co. and Jeffrey Mfg. Co.

How to Plan Cycles for Higher Mine Output

MEN, TIME, AND EQUIPMENT—these are the three basic elements which have to be coordinated as perfectly as possible to produce maximum tonnage in underground mining operations. The method of coordinating them is called cycle planning—a technique which production engineers are striving to perfect everywhere. We have asked two of the nation's outstanding cycle planners (one working in a flat deposit in the East, and the other in a steeply dipping deposit in the West) to outline and illustrate some of the basic considerations in cycle planning, and here are their suggestions. . . .



DAILY MINING CYCLE for room and pillar section of limestone mine. For 8-room panel, 2 shifts of 8 hr. collar to collar.

. . . For Flat Deposits

RAY W. JENKINS, Assistant Manager
Coplay Cement Manufacturing Co., Coplay, Pa.

THE FOLLOWING FLOWSHEET of logic was employed to arrive at the highly efficient mining cycle depicted diagrammatically above. This line of reasoning is applicable to mining areas where all headings and rooms may be reached by haulage or loading equipment. (Usually bedded deposits of non-metallics such as limestone, potash, gypsum, also certain massive metallic deposits.)

Steps in planning the cycle:

1. Determine rate of advance or tonnage requirement per operating hour.
2. From the size of individual headings, determine the linear feet of advance needed for loading each hour to meet the rate.
3. Determine the maximum advance or tonnage per round per room.
4. Determine the number of places that must be available for loading each shift.
5. From physical limitations such as pillar spacing, determine the area or areas which must be served by the loader and transportation equipment.
6. Include in this area the additional headings which must be under preparation, i.e., drilling, timbering, scaling or other operations if it is not possible to do them simultaneously with loading.
7. Considering the physical conditions of the headings, room height, width, clearance of supports, floor conditions, select the loading equipment to be used. Generally for a particular class of conditions, the loader with maximum loading rate and mobility is chosen.
8. After selecting loader, determine the number of headings it can service, including the headings under preparation, to maintain this amount of broken rock. The area covered by each loader is usually called a section.
9. Determine the transportation and ventilation requirements for each section. This should include maintenance and supplies as well as broken rock.
10. Determine the number and type of auxiliary units such as jumbos, compressors, roof pinning machines, etc., to be used in the section. Prime consideration should be to concentrate operations and eliminate long moves and lost time. Operations should be done in as few headings as possible to keep the loader in operation the greatest part of the time.

To accomplish this, set up as well-balanced a cycle as possible.

Problem—Determine the mining cycle for a continuous mobile loader and two diesel-electric shuttle cars which have a loading rate in a section of 110 tons per hr. including setting up and moving time.

The following data has been determined:

Operating time per shift .....6.5 hr.
Tons per shift 715
Room size .....20x12 ft.
Optimum depth of round ..9 ft. V-cut
Ft. of drilling per round 360
Drilling speed (2⅞" drill, 1⅜" hole) .....2 fpm.
Support requirements .....1 row, 5 bolts, 4.5 ft. c.c.
Time per row of bolts .....60 min.
Scaling time .....simultaneous with loading
Tons per round 180
Charging time per round ....45 min.
Rounds per loader shift required....4
Shifts per day 2
Blasting time ....at end of each shift

Drilling Equipment Required:

Try dual jib, self-propelled unit with 9 ft. feed with two 2⅞-in. drills.
Assume—% of drilling speed realized per machine is 75%
Ft. per min. per machine 1.5
Drill time, 1 machine .....240 min.
Drill time, 1 machine .....120 min.
Move and set-up time per room .....30 min.
Drill time per room .....150 min.
Charging time .....45 min.
Jumbo crew time per round..195 min.
Rounds per 6½-hr. shift 2
Jumbos per section 2

Roof Pinning Time Required:

Rows per room 2
Time per row .....1 hr.
Time per round .....2 hr.
Travel time and set-up .....15 min.
Total time, rounds .....2¼ hr.
Rounds per shift 4
Rounds per day 8
Roof pinning, hrs. per day ....18 hr.
Roof pinning shifts per day 3
Units of equipment 2
.....2 operating first shift
.....1 operating second shift

In this case the second roof pinning machine would be used in a second section on the second shift.

All pipe laying, moving loading point, electrical work, ventilation, maintenance should be done on the third shift.

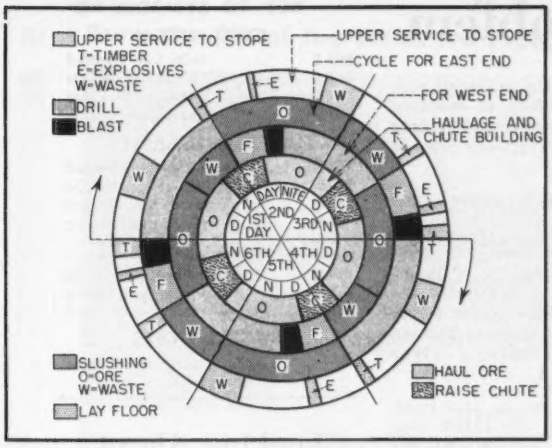
Engineering:

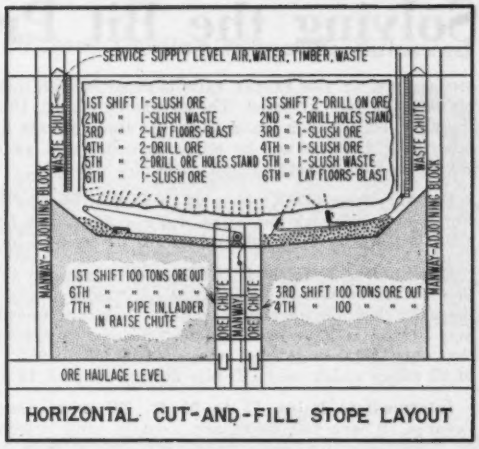
Layout of section on a room and pillar system should be on a 45-deg. system with adequate room at turns for shuttle cars. Breakthroughs to shorten travel time and improve ventilation.

Special details for making turn-outs and starting new rooms should be prepared to standardize methods.

Equipment selected:

1 Continuous crawler mobile loader.
2 Diesel-electric shuttle cars.
2 Self-propelled dual hydraulic jib jumbos with 9-ft. feeds and 2⅞-in. drills.
2 Roof-pinning machines (one to be used in other section half time).
1 Large capacity elevating conveyor.




SERVICE SUPPLY LEVEL AIR, WATER, TIMBER, WASTE
1ST SHIFT 1-SLUSH ORE
2ND " 1-SLUSH WASTE
3RD " 2-LAY FLOORS-BLAST
4TH " 2-DRILL ORE
5TH " 2-DRILL ORE HOLES STAND
6TH " 1-SLUSH ORE
1ST SHIFT 2-DRILL ON ORE
2ND " 2-DRILL HOLES STAND
3RD " 1-SLUSH ORE
4TH " 1-SLUSH ORE
5TH " 1-SLUSH WASTE
6TH " LAY FLOORS-BLAST
WASTE CHUTE
MANWAY-ADJOINING BLOCK
1ST SHIFT 100 TONS ORE OUT
6TH " " " " "
7TH " PIPE IN LADDER IN RAISE CHUTE
3RD SHIFT 100 TONS ORE OUT
4TH " 100 " " "
ORE CHUTE
MANWAY
ORE HAULAGE LEVEL
HORIZONTAL CUT-AND-FILL STOPE LAYOUT

WEEKLY MINING CYCLE for horizontal cut-and-fill stope in which mining and slushing operations are interchanged every 3 days.

. . . For Steep Veins

LESTER BISHOP
Engineering Research Department,
Anaconda Copper Mining Co., Butte, Montana.

CYCLE PLANNING at Butte has gone far to eliminate waste motion and, in this respect, **actually makes work easier for the miner.** In planning a stope cycle, management and supervision is forced to think out in advance all details. This system obliterates grounds for excuses of failure, and encourages one shift to work in harmony with the "opposite shift." Some of the basic considerations employed in working out the cycle for the horizontal cut-and-fill stope illustrated above are as follows:

Time studies are fundamental. The most efficient cycle for a stoping operation may not always be obvious. But time studies of the jobs being done, the number of men employed, sequence of operations, etc., may quickly reveal weaknesses in the operation. For instance, a simple detail such as the location of an ore chute can mean the difference between a cycle requiring two shifts instead of one to complete it.

Ground arch is a prime factor. In general, any cycle is the most efficient when the maximum amount of excavation is obtained consistent with good mining. All of this is dependent upon the strength of the ground arch. If the ground arch is strong, a large excavation and high efficiency are possible. If the ground arch is weak, the size of excavation must necessarily be smaller for safety. Consequently, fundamental steps in the cycle such as barring down, timbering, cleaning down ore, slushing, drilling and blasting must be repeated oftener. Thus the strength of ground arch is the most critical factor in planning the stoping cycle.

Capacity of equipment is important. Questions of this nature have to be answered in planning stope cycles: How many holes can be drilled with one machine? — by two machines? How many cars or tons of ore can be slushed in one shift? Can the chute room be kept available to accommodate the ore slushed? Any time the drillers are blocked by broken ore, or the slushing equipment has to wait for a blast, or both drillers and slushing crews are tied up by a full or hung-up chute, the cycle is out of balance. Each cycle must of course make allowances for unavoidable delays, but the accuracy with which these delays are estimated in advance will go far to determine the over-all efficiency of the cycle.

Service is important. Too often the problem of getting fill, timber, powder, supplies, fresh air, etc., into the stope is not considered with the same degree of thoroughness as the problem of breaking the ore and getting it out of the stope. Nevertheless, service is of utmost importance. Ventilation, properly maintained equipment, timely delivery of supplies, chute room and freedom from interruption by other operations are all necessary for a good cycle. Generally the layout should be planned so that incoming supplies, materials and services come into the stope from above, and outgoing products such as ore should go down by gravity, and out. See example on top of page.

Systematic service facilities should be set up on the levels. Explosives or tools should be available without delay. Timber may be delivered to lesser skilled labor if a time study shows this to be advantageous.

Standardization is required. Standardization of stope layouts leads to standardization of cycles. Confusion would result if there were as many different stope cycles as there were stopes in operation. With standard layouts, men can be trained to do their work more easily, and this is very important today.

Furthermore, if men have to be transported to other working places, they know what steps to take without burdensome instruction by the supervisors.

It is impossible to generalize on the number of man-hours or man-minutes required to perform the various operations of a cycle because these operations will vary according to ground, temperature, men, kind of supplies needed, and nature of the work. However, in the cycle shown above for the horizontal cut-and-fill stope the timing of operations is planned roughly as follows:

1st shift. Two men drill from ore pile on east side. One man slushes on west side of stope.

2nd shift. Two men drill from ore pile on east side. (Let holes stand.) One man slushes on west side.

3rd shift. Two men lay floors on west side and blast previous round. One man slushes ore on east side of the stope.

From here on, the cycle is repeated with the sides reversed, i.e., Two men drill from ore pile on west side. One man slushes on east side, on through the cycle.

Solving the Bit Problem

ONE GLANCE AT THE FACING PAGE is proof enough that the universal rock bit has not been invented. The problem remains, therefore, of selecting the right bit for each job. A thorough study of case histories and drilling reports by districts and by mines indicates that generalizations are not advisable. However, the following guides will help:

For very long holes, above 60 to 70 ft. Here the DD bit proves best. For very hard rock the DD-C type is best, but for softer rocks the DD-NC types may be faster because no time is lost for core pulling.

Long holes, 30 to 60 ft. Choice rests between DD and TC-T types. Steel bits are ruled out because of excessive gage loss. Despite the increase in diamond costs, and the fact that mines like Howe Sound and Britannia have switched to TC-T drilling, there is no indication that this trend is general. (See E&MJ Sept., 1950 containing a survey of 50 mines which used DD bits during the past 15 yr.)

Intermediate holes, 15 to 35 ft. TC types seem to be the most favored. Where DD types are used in ring drilling, the entire ring of long holes including intermediate holes may be drilled with the same machine.

Short holes, up to 12 or 15 ft. All types except DD types are competing heavily in this range. Striking gains have been made by SU types, paralleling a marked increase in the use of TC types with light drills and air-feed legs for certain drilling operations.

Cost of bits. This item is not always a critical factor, but overall cost per foot of hole drilled is. Thus bit costs must always be weighed against companion cost factors such as setting-up time, drilling speed, compressed air consumption, labor, steel breakage, etc.—all of which enter into the total cost per foot. Nor should other collateral benefits be overlooked, such as lower blasting costs due to smaller and more uniform bore drill holes afforded by TC and SU-T types. Sometimes the most expensive bit is actually the cheapest.

Drillability of rock. Hardness, abrasiveness, and resistance to impact of a rock may have a profound influence on bit design. Manufacturers' literature is generally quite specific in explaining variations in bit design and pointing out range of applicability. Note for instance on the opposite page that a bit may have 1,2,3,4, or 6 cutting edges, also that some designs have truncated cutting edges to minimize gage loss and excessive initial stress on the cutting edge; also that some bits have a pilot construction to provide 2-stage penetration of the rock.

Rotary drilling with TC-tipped augers is receiving more attention for soft ores. It is expected that drilling with this equipment will increase on the Marquette iron range. South African chrome producers report good results with the TC-tipped auger in rock with hardness not exceeding 4 to 4.5.

Matched Equipment. German miners who pioneered in tungsten carbide drilling soon found out that the success of the new technique would depend as much on life of the drill rod as on the inserts. Consequently they went to slower drilling speeds and lighter drills to reduce rod breakage. This aptly illustrates that choice of bit cannot be made independently of the type of connection, the rod, the machine, air pressure etc.

Wanted—A way of correlating drilling data. Case histories and data on drilling performance are abundant. But there is no common denominator such as "drillability" of rock which will enable an operator to determine exactly how applicable the published data is to his own drilling problem. Metallurgists, however, have the standard Rockwell scale to determine hardness of steel. This suggests that a standard test drill might be devised operating on standard feed and air pressures, using a standard series of bits ranging from steel to TC, to enable operators to classify rock drillability in terms of inches per min. Thus, for example, a drill report might specify drillability of a rock as "2 ipm. on the standard T scale (tungsten carbide) or 1 ipm. on the S scale (steel)." Such a test unit might also serve to classify rock for settling contract drilling rates.

KEY TO SYMBOLS ➡

STEEL BITS

MU-T ..... Multi-Use, Threaded
MU-S ..... Multi-Use, Slip-On
SU-T ..... Single-Use, Threaded
SU-S ..... Single-Use, Slip-On

TUNGSTEN CARBIDE

TC-T ..... Tungsten-Carbide, Threaded
TC-S ..... Tungsten-Carbide, Slip-On
TC-I ..... Tungsten-Carbide, Integral
TC-R ..... Tungsten-Carbide, Rotary

DIAMOND DRILL BITS

DD-NC ..... Diamond Drill, Non-Coring
DD-C ..... Diamond Drill, Coring
DD-R ..... Diamond Drill, Reaming Shell

SPECIAL TYPES

HF ..... Hard-Faced Suction Bit.

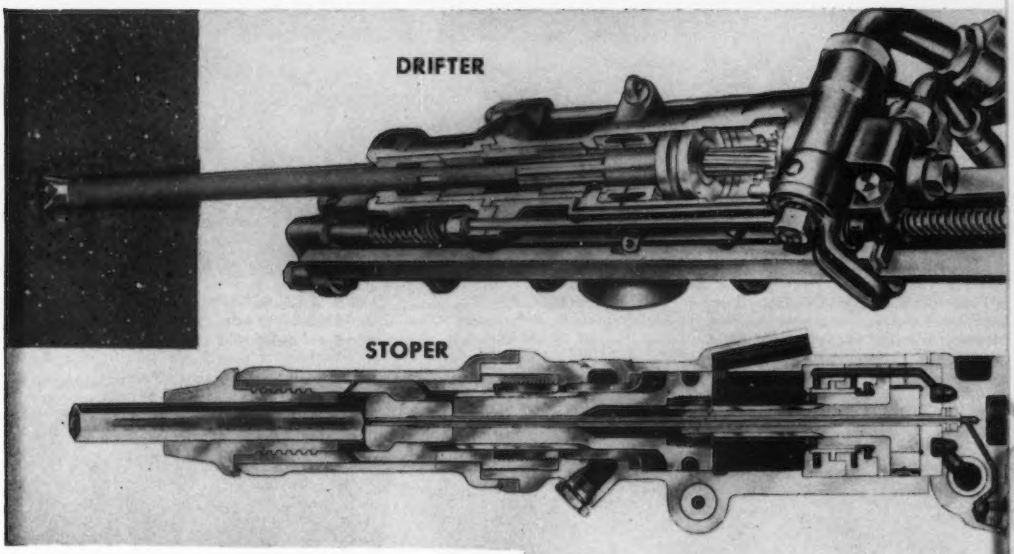
Looking Ahead

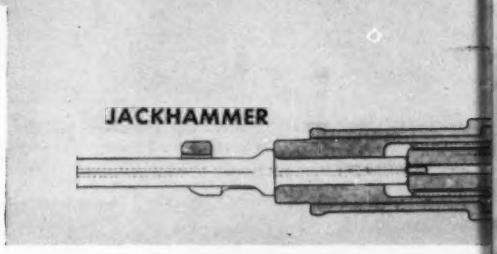
FOR SEVERAL YEARS E&MJ's editorial offices have been receiving sporadic inquiries about some new method of "disintegrating rock" by super-sonic or other high-frequency vibrations, so naturally we have been hot on the trail of any clues we could find. At the moment, here is what we have been permitted to publish on the subject by a research organization that is working on new methods of drilling:

"A broad investigation of novel methods and means for making holes through earth and rock formations was initiated in 1949 by Drilling Research, Inc., a corporation owned by forty oil companies and oil-well drilling contractors. Among the processes studied have been those employing the electric arc, rocket jets, high-speed grinding, and vibratory phenomena over a wide band of frequencies.

"At the present time, greatest promise, at least from the short range viewpoint, has been shown by vibratory drilling, and present efforts are being concentrated on developing this method beyond laboratory stage to field trial. Some of the major problems encountered were: development of high-power, high-frequency generators; the down-hole transmission of power; and determination of characteristics of the system such as optimum frequency and load impedance. While laboratory results have been most encouraging it still is too early to say whether or not the process can be made commercially successful."

From the Tip of the Bit to the Feed, Efficient Drilling Demands Balanced Des





Why Balanced Design Is Important

THE ROCK TO BE DRILLED is the one inflexible factor involved in drilling. Hardness, abrasiveness, compressive strength, resistance to penetration (plus length and diameter of hole), determine largely what type of bit should be used. Resistance of rock to penetration of the cutting edges of the bit (drillability) is of utmost importance, for if the blow of the piston (based on piston diameter and air pressure) is excessive, the surplus energy must be absorbed by the steel and drill parts. If the blow is too weak, drilling will be slowed up. Hence the need for balance in design of all the variable elements of the drilling ensemble.

So important is drillability of rock that one progressive company based its **entire mining cycle** upon the bit selected to penetrate the rock. Once the optimum bit had been selected, all other elements such as the drill steel, machine, number of machines per jumbo, drilling time, were determined successively until finally the entire cycle hinged upon the rock bit.

Bit attachment. Careful study of the numerous modes of bit attachment on the previous pages is proof enough that this problem is vital. C. H. Hopper, drilling expert, reported (E&MJ, April 1950) that with the advent of the TC-T 4-point bit "the life objective of a connection is now 100 times the objective that plagued the industry with the development of the steel detachable bit." Every bit manufacturer strives to make his attachment strong enough to transmit the forces of the rock drill from the steel to the cutting edge of the bit. In the MU-S and SU-S types, the aim is to make the bit stay on.

The Steel. Mining men know that they must hold steel breakage to a minimum, but the finer art of steel heat treatment (or shot peening to combat fatigue, or even induction heating of the shanks or threads) is not too well understood.

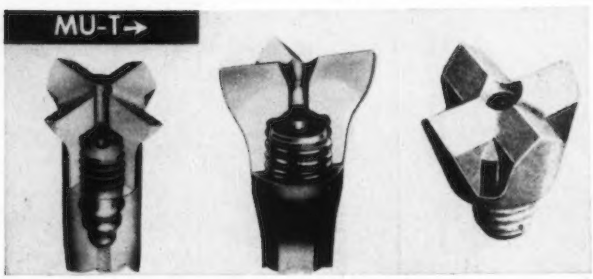
On the Menominee range, opinion seems to be that alloy steel offers little advantage over carbon steel. But from the U. S. Bureau of Mines oil shale operations at Rifle comes this startling observation—that alloy rods gave drilling rates 25 to 35% faster than carbon rods. Why? The Bureau proposes to find out. Perhaps these may be partial answers: (1) As much as 20% of the energy of the blow of a drill may be absorbed in production of heat and in the drill steel, and (2) a harder, more elastic alloy transmits the piston blow more efficiently than carbon steel rods, according to metallurgists of Crucible Steel Co., who say that block tests in the laboratory show that alloy bars whip less than carbon rods, and their rebound is more violent.

Clearing out the cuttings. For long-hole work, some companies favor the front-end water swivels which cause air and water to bypass the drill and enter the steel through an annular ring. Others prefer to use a new ring-seal shank which has proved effective in holes up to 70 ft. in transmitting water and air from the water needle of the drill to the steel.

Down-stroke or up-stroke rotation? Rotation of the drill rod on the down stroke or up stroke of the piston is dependent on design of flutes on the rifle bar and rifle nut. Manufacturers who make both types say that the advantage of one over the other is highly controversial. However, on the down-stroke (power stroke) type some of the energy of the blow goes into rotating the steel, whereas on the up-stroke type this energy loss does not interfere. Greenwood mine on the Marquette Range reports that a change to slower rotation on the up stroke increased TC bit life by 50%; and the Champion mine reported that up-stroke rotation increased drilling speed by 10%. J. Fred Johnson,[1] Manager of Western Operations, AS&R, says "In some cases downstroke rotation increases drilling speed and ease of operation. But this

[1] American Mining Congress, Salt Lake City, 1950.

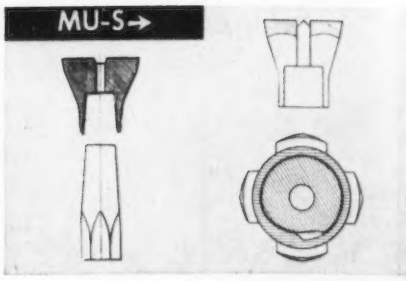
An Efficient Production Cycle Starts With the Rock Bit



I-R STUD JACKBIT — Jackbit is attached by stud swaged in drill steel.

TIMKEN—Bit shoulders on drill steel. Threads don't bear shock.

RIP-BIT — Stud forms part of bit. Withstands milling or grinding.

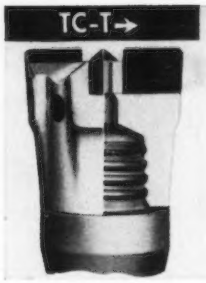


SIMPLON — Copper sleeve lines socket to aid firm attachment to steel.

CRAIG—Spiral of Archimedes construction locks bit on steel.

THROWAWAY — Easily deformable skirt fits over steel end.

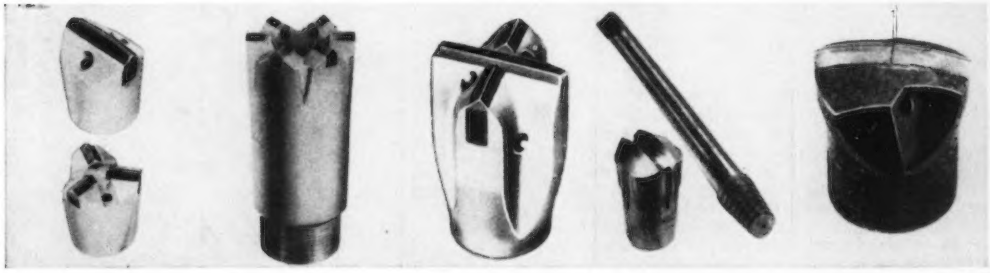
HOLMAN SUCTION TYPE—Holes enable bit to suck dust.



I-R CARSET—New reverse buttress thread takes up shock.

I-R STUD CARSET—Attachment is same as for Stud Jackbit above.

ROK-BIT — Crown insert bits available sizes up to 4 inche



KENNAMETAL — Chisel type is for hard ground, 3-point for hard & med.

KENNAMETAL Chopping — For exploratory and blast-hole drilling.

FIRTH STERLING—For drilling highly abrasive and very hard rocks.

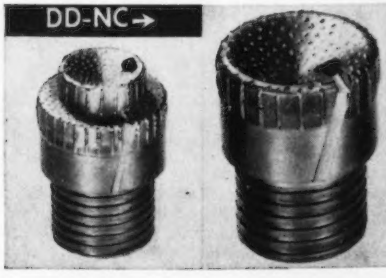
AUSTRIAN Make—Features double chisel edge and buttress thread.

BELGIAN Make—Chisel insert consists of two alloy pieces.

KENNAMETAL Non-Coring—Rotary type for medium hard formations.

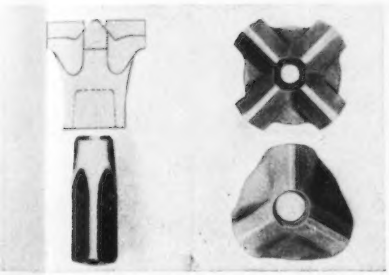
TC-TIPPED Auger — Used in rocks having hardness below 4 to 4.5.

HARD-FACED — Hard-facing is applied by electro-welding methods.



PILOT TYPE CONCAVE TYPE

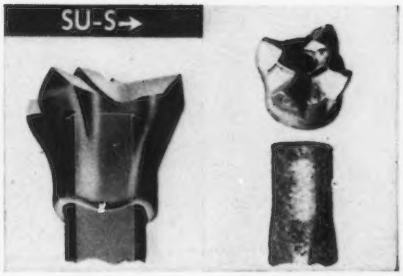
Non-coring DD bits are used in blast-hole drilling where core-pulling slows down progress.



HAYES P&M—Differential taper between socket and steel causes gripping.

HAYES P&M—3- and 4-wing types with truncated cutting edges.

JOY THROWAY — Designed to drill smaller and deeper holes.



TIMKEN SPIRALOCK—Crowned chisel edge aids starting and collaring.

LIDDICOAT — Features 2-stage cutting action, pilot cut, then wing cut.

JOY SULMET—Designed for longer feeds in hard rock. No hole taper.

TIMKEN "FC" Series—Designed for small holes and severe conditions.

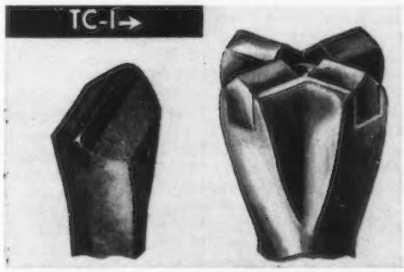
TIMKEN "DC" Series—For deep-hole drilling requiring large holes.

MILLFORD—Fits standard rods. Sizes range from 1⅝ to 2½ in.

RIPLOY — Unusual feature is continuous insert across center of bit.

HOLBIT — Copper shim is used to attach bit socket to steel.

WALLRAMIT — Dutch-made bit with tapered shank for attachment.



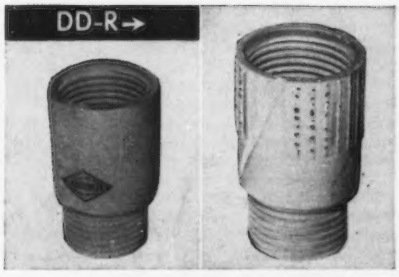
COROMANT — Famous Swedish chisel bit on alloy-steel drill rod.

BLACK'S BIT—Forged to yield better chip clearance and straight hole.

KENNAMETAL Coring—For drilling in shale, slate and limestone.

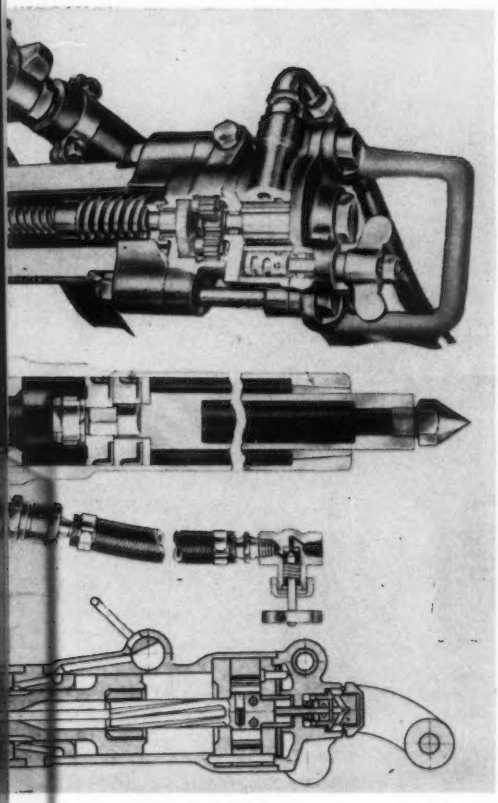
CORING TYPES OF DIAMOND DRILL BITS

A wide variety of coring types are available with matrixes of copper, beryllium, tungsten or nickel alloys or of powdered metal alloys.



TYPES OF REAMING SHELLS

The reaming shell determines the diameter of the hole to be drilled and should be checked often for gage loss.



effect is due to softening of the blow and might better be accomplished by using a slightly smaller machine."

Speed of rotation. This depends upon pitch of the rifle bar and ratchet design. Here again Mr. Johnson sums up the problem as follows: ". . . a primary task of the machine is to turn the drill steel a certain fixed amount for each blow. Hence, the correct degree of turn corresponding to each blow of the machine, the correct strength of that blow, the correct number of blows per minute, and, of prime importance, the largest machine to do this without straining the drill rod and drill bit must be used to achieve penetration at lowest cost."

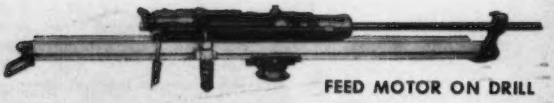
Force of the blow. The force of the piston blow must be maintained at an intensity which the bit edges will be able to transmit into cutting action. If the blow is too strong, the bit fails; if too weak, drilling speed drops excessively.

Drill Feed and Support. Phenomenal strides have been made in the last decade to eliminate effort of holding the drill with jumbos including track, rubber-tired and tractor types, also collapsible stope models, and shaft jumbos. Various drill positioning devices have been introduced, including hydraulic and mechanical types. Long feeds (up to 96 in.), possible on boom and jib type jumbos, increase drilling efficiency.

Feeding devices for the drill have also undergone marked improvement. Note for instance the feed motor on the shell and on the drill in the adjacent illustrations, and the many adaptations of the pneumatic feed. Ingenuity of manufacturers and miners has been so pronounced that we actually find drifters on pneumatic crossbars used as sinkers, and sinkers (jack hammers) on pneumatic legs used as stopers and drifters, and stopers (reverse feed) used as drifters and sinkers.

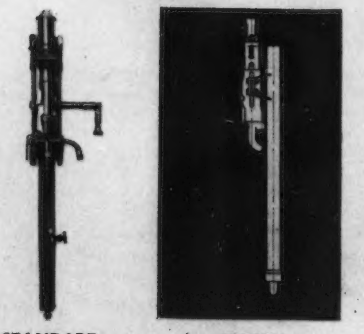
THE FEED -- A Vital Factor

FEED MOTOR ON SHELL



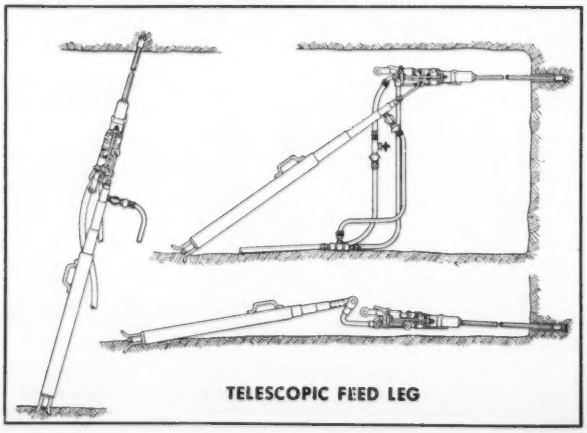
FEED MOTOR ON DRILL

AIR FEED SINKER



STANDARD SPECIAL SAFETY

TYPES OF STOPERS



TELESCOPIC FEED LEG

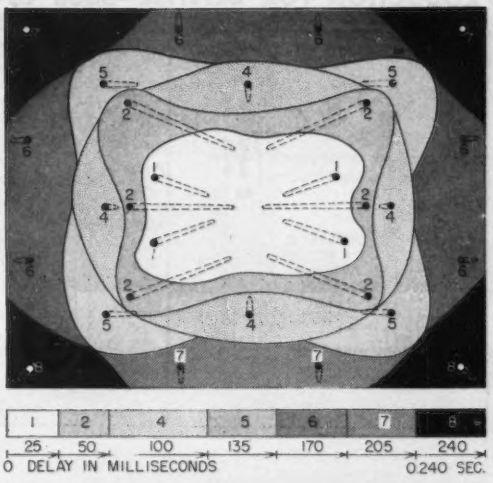
BLASTING AIDS TO BOOST PRODUCTION

SPLIT SECOND DELAY

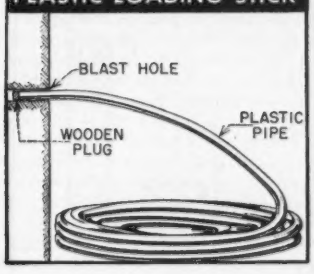
Split-second delays, variously known as short delays, millisecond delays, fast delays, or short-period delays, rank high in the list of modern blasting developments. Advantages widely recognized through the use of these delays are: (1) Better fragmentation and less secondary blasting. (2) Reduced concussion. (3) Less vibration in country rock. (4) Less back-break and over-break. In other words, precision timing of the shots in a round permits the explosives to work on the rock being excavated, rather than shaking up the country-side or producing worthless concussion.

Explosives experts describe split-second timing as a means of "peeling" successive layers of a round. A typical split-second development round is shown at right. Longest of the 7 delays used is only 0.240 sec.

Most startling observation made thus far is that split-second blasting appears to set up incipient strains in blasted rock which makes it easier to crush. Consistent results of this nature may mean that the through-put of a crushing plant can be increased considerably during a given period of time.



PLASTIC LOADING STICK



At Last—an ideal loading stick for long-hole blasting has been devised. It consists of a coil of plastic pipe, approximately ¾-in. in diameter to replace segmented or jointed types of wooden loading sticks. See E&MJ, Feb., 1951, p. 113.

SAFETY IN SPITTING THE ROUND

Modern blasting devices to insure positive spitting of single and multiple-shot blasts include:

1. **Electric blasting caps with plastic-covered lead wires** plus fool-proof control over closing of blasting circuits and proper checks for stray currents.

2. **Ignitacord**—an external-burning fuse (at about 45 ft. per sec.) which acts both as a timer and igniter. Fuses leading to holes are split and wired to the ignitacord. Timing is obtained by spacing the fuse along the trunk line. As many as 125 holes have been blasted successfully by this method.

3. **Pull-wire fuse lighter**—a device which slips over the square-cut end of a fuse like a socket. The fuse is ignited by simply pulling a short wire with convenient cross handle.

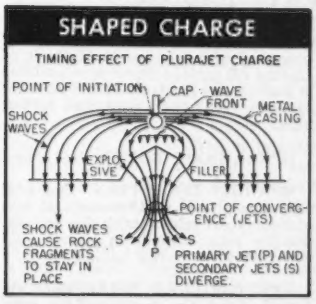
4. **Hot-wire safety-fuse lighters** consist of 7, 9, or 12-in. lengths of wire coated with a flammable composition (except for the part held in the hand). When ignited, this lighter presents a hot even-burning ember for igniting fuses.

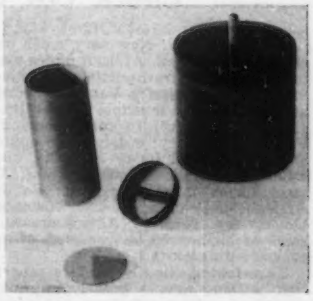
5. **The lead spitter** is a small diameter lead tubing filled with black powder. When ignited, the burning core is used to spit safety fuse. The lead tubing melts as the core burns.

6. **Cheesa sticks**, used in Africa, consist of paper cartridge filled with barium nitrate and potassium chlorate. A strontium salt placed near the stump burns red when the stick is nearly burned out.

7. **Bunch blasting**—not new but still very effective. Consists of bundling two groups of square-cut fuse ends; igniting one bunch and spraying flame against face of other bunch until all fuses are ignited.

SHAPED CHARGE

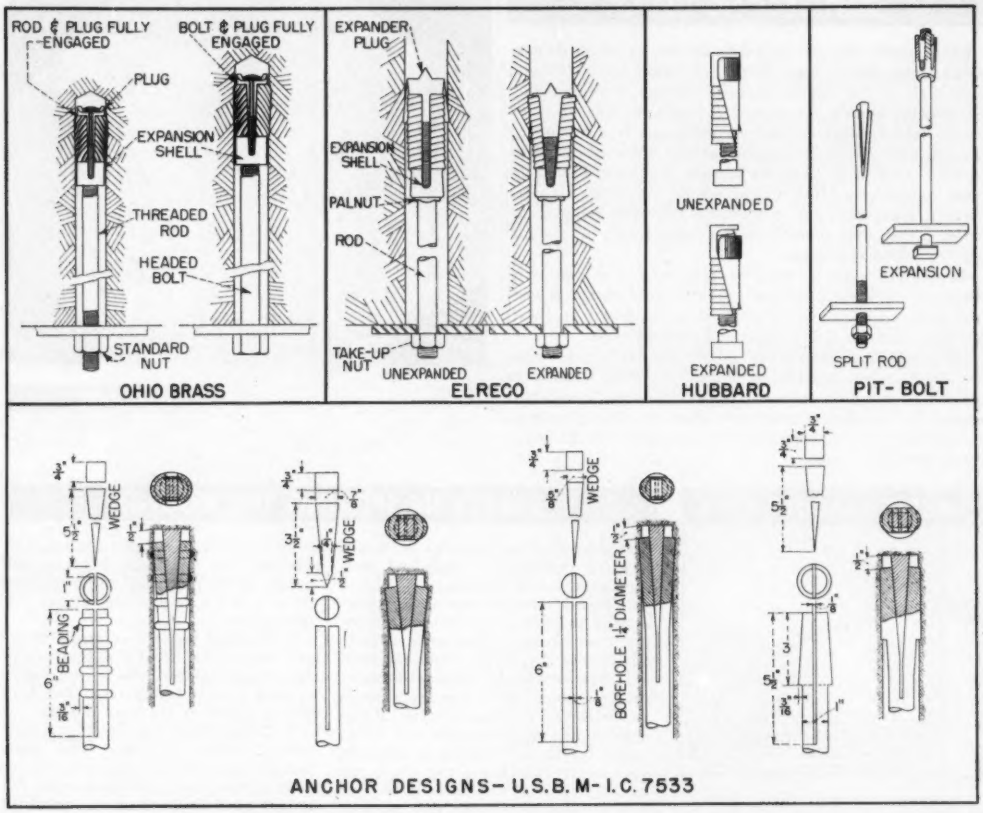




Steel-Cased shaped charge (at left) called "Plurajet" for underground and open-pit mines produces concentrated primary wave front which converges to penetrate boulder and then diverges to rip it apart. Milliseconds later shock wave slams down on the surrounding area to prevent fragments from flying. Boulders up to 20 tons have been shattered to crusher size by this method. Variation of "Plurajet" (center) affords blow of extraordinary striking power due largely to annular cavity surrounding central cavity. Explosives are filled in space between top and bottom steel forms shown above.

Cardboard charges at right were used with great success at Consolidated Coppermines in Nevada some years ago. Small size is 2½ in. in dia. and larger is 4½ in. Charges hold 1½ and 7 stick of semi-gelatine powder respectively. Smaller one is disassembled to show 40-deg. cone bottom and cap with tube for primer.

PRODUCTION FOR DEFENSE—Good Ground Support Is Vital



ROOF BOLTING. Introduced by St. Joseph Lead Co. years ago, this technique is now revolutionizing ground-support methods in the coal mining industry, and undergoing widespread adoption in metal and non-metallic mining. Advantages of this system of rock pinning are: saving in labor, less obstruction to haulage equipment and ventilation currents in tunnels, reduced cost of handling ground-support material, greater resistance to decomposition than wooden supports, more permanent and dependable support.

Check List of Modern Ground Support Methods

CONCRETING. Now very much on the increase. South African mines are far advanced in transporting and placing concrete in shafts. Van Dyke mine used bucket with multiple hose outlets (called "Octopus") to speed pouring. Forms used vary widely. One mine uses locked-steel forms in drifts, another uses track-mounted extensible steel forms in slusher drift; South African mine uses pre-cast concrete blocks for forms. (Advantage—no steel or timber to be removed after concrete lining sets.)

Experienced mine concreters report that wetting agents greatly improve the quality of concrete because a more intimate bond between cement and aggregate is made possible.

PRE-STRESSED CONCRETE. Concrete members gain tremendous strength if reinforced with tensed steel rope. One method consists of casting tensed cables within the beam; the other of casting tubular openings, in the beam and later inserting cables. Cables are tensed and anchored to ends of the beam. A European company used pre-stressed beams for railroad ties. Similiar members made with old hoisting rope could be used for drift caps.

CONCRETE LATHS. Cleveland-Cliffs lags over steel drift sets with pre-cast concrete laths. Advantage—fire prevention.

GUNITING. Still very useful to prevent slacking and resultant spalling. One mine applies guniting over a network of old hoisting cable secured by expansion bolts.

PLASTIC FILM. Coal mines spray acid-proof plastic called "cocoon" over surfaces to prevent air slacking and spalling.

STOPE FILLING. Materials used include waste rock, surface sand and gravel, mill tailings, granulated slag cemented with iron oxide. Methods of placing fill include pneumatic systems in Europe and Australia, and hydraulic systems employing steel and rubber pipe.

STEEL ROOF BOLTS. See above.

WOODEN ROOF PINS. One coal mine has pinned up thousands of feet of roof successfully with 2⅝-in. dia. wooden pins wedged in place. Acid water prevented steel bolting.

STEEL PILLAR WRAPPING. St. Joseph Lead Co. wraps pillars with old hoisting rope to increase support value.

TIMBERING. Still the most common means of support. Life of timber is greatly increased with preservatives, and over-all costs are reduced with mechanical materials handling units. (See p. 155)

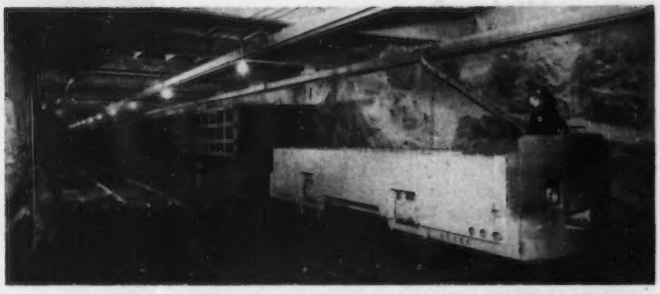
Loading & Hauling Progress

PRODUCTION PLANNERS are working energetically toward a more perfectly balanced loading and haulage cycle—with emphasis on keeping the loader busy as much as possible, and gearing the haulage equipment to loader output. It is also recognized that bigger haulage equipment means lower costs per ton. That is why we see huge 20-ton trolley locomotives installed at Inco (destined soon to be the world's largest underground producer), and the 32-ton trolley locomotive at Birmingham, believed to be the largest unit in underground operation (See page 115).

Diesel powered equipment is gaining wider acceptance. Notable progress is being made in scrubber design to purify gases. U. S. Bureau of Mines developed a satisfactory scrubber at Rifle to remove aldehydes which contains a solution of 15 gal. water, 15 lb. sodium sulphite, and ¾ lb. hydroquinone. Oxygen injection is also serving well. (See page 114) Newest addition to the diesel-powered family is the diesel-electric shuttle car which according to one user is performing exceptionally well.

Compressed air. Mining men have long sought a trammer which would fill in the gap that existed between hand tramming and the small battery trammer. In recent years this need has been filled by small compressed-air trammers operating on normal mine air pressure of about 100 lb. It is light, comparatively inexpensive and can be moved readily to inaccessible places such as intermediates. Compared to savings in wages afforded by the air trammer, compressed air consumption is but a small item. In fact, one Colorado operator summed it up this way, "It takes about as much compressed air to charge the trammer as it does to run a rock drill a minute or two, and you wouldn't worry about that amount of compressed air in any mine." The charge referred to was sufficient to tram out two loaded mine cars several hundred feet. These trammers are now being used in the United States, Mexico, Central America, Cuba, South America, South Africa and elsewhere.

The table at right sums up a study of loading equipment for flat trackless mining made by Ray Jenkins, author of the cycle planning article on page 108.



20-TON TROLLEY unit hauls 260 cu. ft. ore cars at International Nickel Co.

NEW DIESEL-ELECTRIC shuttle car proves successful at non-metallic mine.

COMPRESSED-AIR trammer hauls loads up to 20 tons on 100 lb. air pressure.

Loading Equipment for Flat Trackless Mining

Room Height	Room Width	Loader Unit	Haulage Unit	Tons per Hour	Loader Mobility
Up to 36 in.	All	Mobile Scraper	Belt	20 to 30	Poor to Fair
		Slide	Shaker Conveyor		
36 in. to 90 in.	To 10 ft.	Scraper Slide	Belt, Shaker	30	Fair
	To 10 ft.	Scraper Slide	Shuttle Car	30	Fair
	Over 10 ft.	Continuous	Shuttle Car	50	Good
90 in. to 17 ft.	To 10 ft.	Scraper Slide	Belt	50+	Poor
	Over 10 ft.	Scraper Slide	Shuttle Car	50+	Fair
	Over 10 ft.	Overshot Shovel	Dumptor	60	Good
	Over 18 ft.	Front End Shovel	Dumptor	50	Good
	Over 18 ft.	Front End Shovel	Shuttle Car	50	Good
	Over 10 ft.	Continuous Loader	Shuttle Car	120	Good
Over 17 ft.	To 10 ft.	Same as above	Same as above	As above	Good
	10 to 25 ft.	Same as above	Same as above	As above	Good
	Over 25 ft.	Short Boom Shovel	Dumptor	150	Fair

Bilharz Mining Co.

VERSATILITY AND MOBILITY of loading units at the Muncie mine of the Bilharz Mining Co., Baxter Springs, Kas., are largely responsible for the increased production and lower mining costs of the operations. Ore is picked up with the 1.5-cu. yd. rubber-tired loader shown at right and loaded into 10-ton rubber-tired dump trucks for haulage to the shaft. The new type loader averaged 400 tons per 8-hr. shift over a 2½-month period as compared with 280 with previous less-mobile loading equipment. Versatility of the loader is evident from the following tasks which it performs: road building, roof trimming, general clean-up work, grading, spreading, loading and dumping. The following table summarizes benefits of mechanization:

BEFORE MECHANIZATION—4 months, 1950				
Tons per man-shift	5.60	6.95	6.36	6.56
AFTER MECHANIZATION—4 months, 1950				
Tons per man-shift	15.36	14.00	13.26	12.18

Mining costs were commensurately lower.

FOUR-WHEELED DRIVE diesel-powered loader, is equipped with oxygen injection system.

Eagle-Picher Mining & Smelting Co.

EAGLE-PICHER'S OPERATIONS in Oklahoma have been a virtual proving ground for modernized mechanization under the able direction of S. S. Clarke, general superintendent. Diesel-powered trackless loading and haulage units were pioneered here, as well as many types of trackless jumbos. A high mast jumbo reaching 35 ft. in the air, accounts for the increase in tonnage per drill shift shown in the table below, which compares efficiency before and after highly mechanized units were adopted.

	BEFORE		AFTER	
Mine	Tons per drill shift	Tons per man-shift	Tons per drill shift	Tons per man-shift
Blue Goose	45.0	5.6	80.00	15.8
Webber	65.8	6.8	121.0	15.8
See Sah	51.2	7.8	84.0	20.4
Big John	38.8	5.3	52.0	10.7
	1939		1951	
All Mines	42.3	6.0	76.0	15.0

DIESEL-POWERED, tractor-mounted loader fills rubber-tired trailer unit at Eagle-Picher mine.

TCI's. Modernized Program

THE ENTIRE MINING INDUSTRY has been watching TCI's trackless mining system with continuous loaders because it marks one of the first adaptations of this combination in heavy, abrasive iron ore. Equipment used includes tractor-mounted continuous loaders, bucket-type shovel loaders, cable-reel shuttle cars, rubber-tired jib-type drill jumbos, roof-bolting equipment, bulldozers, 32-ton trolley locomotives, and 8-wheel 10-ton mine cars. Benefits of this modernization program in panel mining were as follows:

1. **Direct panel mining costs have been lowered about 12%.**
2. **Development mining costs are about 20% less.**
3. **Tons per man-shift have increased from 14 to 23.**
4. **Accidents are fewer and ventilation control is better.**
5. **Less dilution through better roof control in panels.**

Capacity of the loader shown at right is 8 to 10 tons per min. Highest weekly average tonnage per shift for a loader was 748 tons, and highest tonnage for a single shift was 920 tons.

CONTINUOUS-TYPE trackless loader picks up heavy, abrasive iron ore, discharges into cable-reel shuttle car.

Through Modernized Loading and Haulage

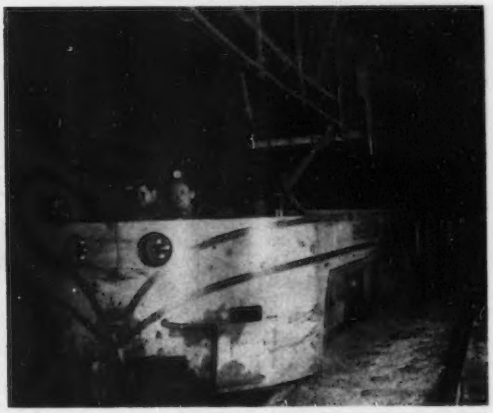
ROOF TRIMMERS are hoisted 16 ft. in the air to trim the back to a safe arch. Men trim four "faces" per day.

LOADER digs down-hill or up-hill and can be used for grading, road building and clean-up work.

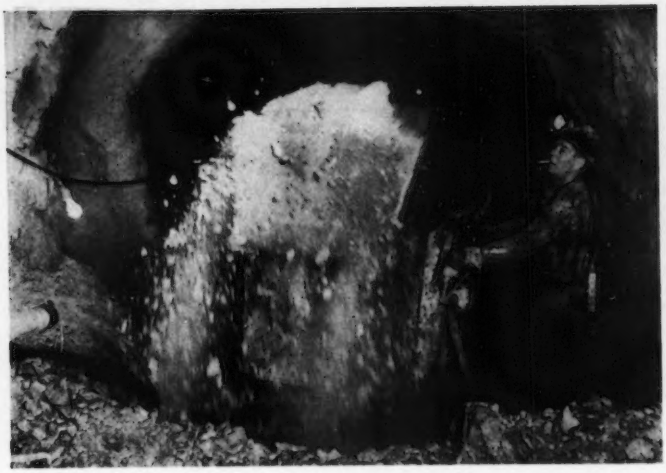
TRACTOR-MOUNTED ROCKER SHOVEL, also diesel powered, swings its load over the top into trailer.

RUBBER-TIRED, diesel-powered truck and trailer await load at tractor-mounted scraper-slide loader.

CABLE-REEL SHUTTLE CAR, carrying 14-ton load, discharges ore in cars. Travel speed is 2 mph., loaded.

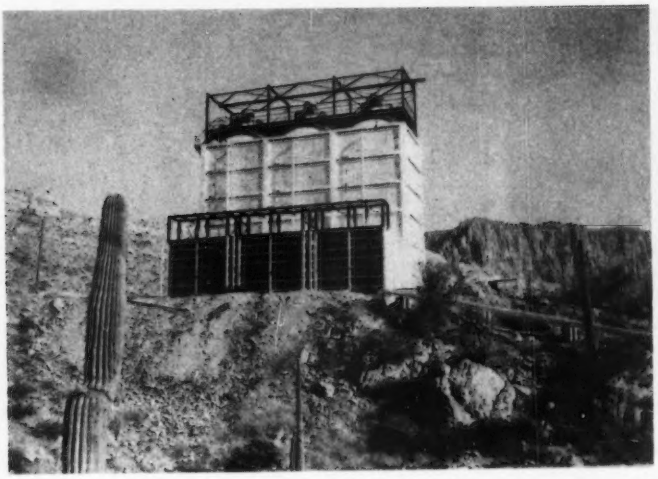


NEW 32-TON TROLLEY LOCOMOTIVE hauls loaded 10-ton mine cars, each mounted on two 4-wheel trucks.



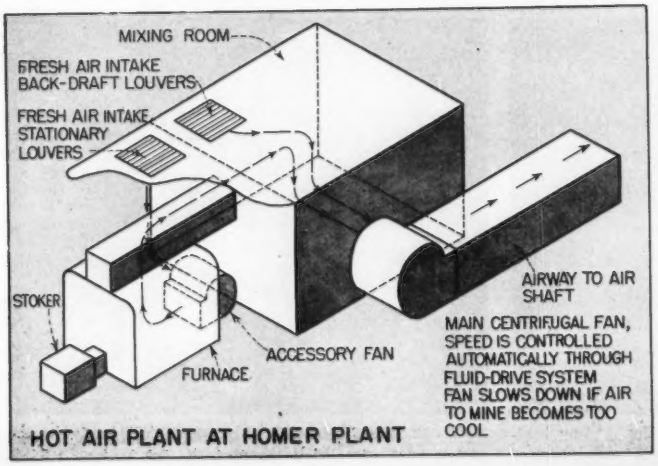
LIGHTING

WHEN A MAN'S PRODUCING like the fellow on the left he wants to see what he's doing, and it's only logical to give him enough light, either through a string of bulbs, as shown, or with floodlights. The advent of widespread mechanization in all phases of mining activities is responsible for the present increasing use of illumination in stopes, shafts, drifts, and raises primarily because a worker can't run a big unit such as a slusher safely and efficiently without lights, and secondly because much of the equipment is electrically powered; hence electric circuits are automatically available for lighting. Mercury vapor lighting is gaining favor for shaft stations, pump rooms, etc. because of great savings in power costs for lighting.



COOLING

MAGMA COPPER CO.'S recently completed cooling system is doing the job its designers planned. Because of the desert climate, the evaporative system works well. Water for the cooling tower is pumped over a 16-mile pipe line to supply the tower. Cool water is circulated through a high-pressure pipe line in the shaft. It absorbs heat from low pressure circulating systems through heat exchangers on various levels. Low-pressure systems in mine, involving circulation pumps, fans, sprays, and cooling coils, provide large volumes of cool air for men at the face. Magma Copper also employs spot coolers which together with the main cooling unit, lower humidity in working places, thus minimizing the twin discomforts, heat and humidity.


MIXING ROOM
FRESH AIR INTAKE BACK-DRAFT LOUVERS
FRESH AIR INTAKE STATIONARY LOUVERS
STOKER
FURNACE
ACCESSORY FAN
AIRWAY TO AIR SHAFT
MAIN CENTRIFUGAL FAN, SPEED IS CONTROLLED AUTOMATICALLY THROUGH FLUID-DRIVE SYSTEM FAN SLOWS DOWN IF AIR TO MINE BECOMES TOO COOL

HOT AIR PLANT AT HOMER PLANT

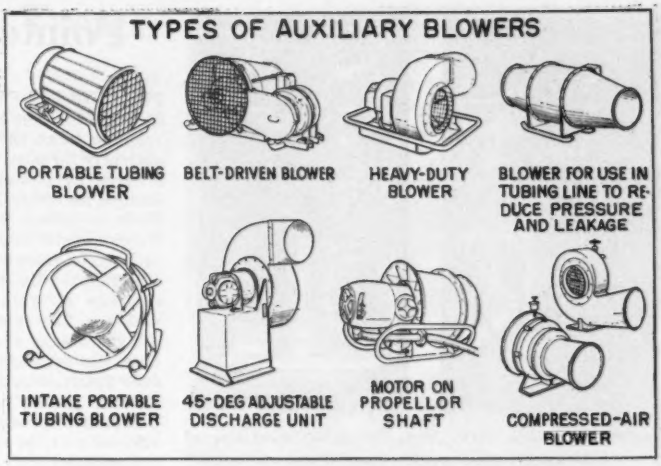
HEATING

THE HOMER MINE on the Menominee Range has an elaborate heating system (U.S.B.M. I.C.7596). It is of the hot-air type, completely automatic, and designed to maintain entering air at 36 deg. F. or above. Fresh air to the mine is supplied by an 80,000-cfm. main centrifugal fan, which blows to the mine and exhausts from the furnace. A 50,000-cfm. auxiliary fan forces air through the furnace. Temperature of the fresh air entering the mine is controlled by a thermometer. Speed of the main fan is controlled by a scoop-control hydraulic coupling. As temperature of the air entering the mine drops, the main fan speed drops accordingly, to maintain proper temperature of air in the air shaft.

Goes Up with Worker Comfort

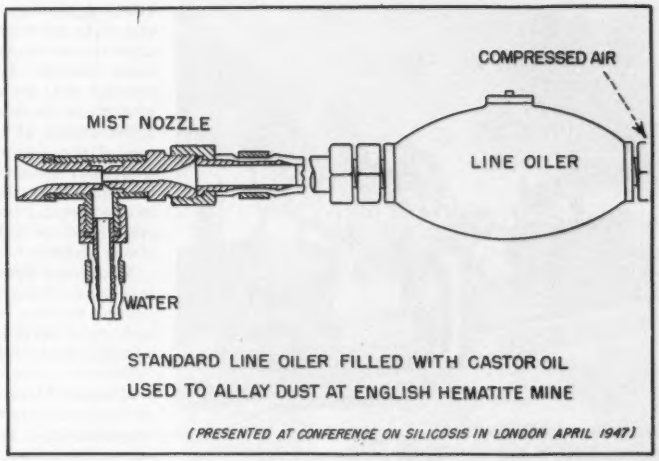
VENTILATION

PRODUCTION ENGINEERS emphasize the importance of auxiliary ventilation equipment in speeding up the mining cycle. Delays due to powder smoke in the headings and stopes can be minimized with the various combinations of blowers, boosters, ventilation tubing and pipe now available. Hecla engineers devised an armored car housing a blower and several spray jets which was anchored fairly close to a tunnel face to stir up the gas-laden air immediately after the blast for removal by the exhaust ventilation line somewhat removed from the face. This system was vital in cutting down delays due to dust and gases in an important tunnel-driving campaign. Note various auxiliary blowers at right.


TYPES OF AUXILIARY BLOWERS
PORTABLE TUBING BLOWER
BELT-DRIVEN BLOWER
HEAVY-DUTY BLOWER
BLOWER FOR USE IN TUBING LINE TO REDUCE PRESSURE AND LEAKAGE
INTAKE PORTABLE TUBING BLOWER
45-DEG ADJUSTABLE DISCHARGE UNIT
MOTOR ON PROPELLOR SHAFT
COMPRESSED-AIR BLOWER

DUST CONTROL

THE BEST UNIVERSALLY recognized dust-control method is a good ventilation system. Mines like Climax have spent more than $1,000,000 to install a good exhaust ventilation system to combat dust hazards. Interest in aluminum therapy in U. S. A. has abated largely due to discouragement by the American Medical Association. Notwithstanding, this method of therapy is still successful and widely used in Canada. U. S. Bureau of Mines has shown that the use of slight amounts of wetting agents in drilling water increases dust abatement during drilling. Note also the mist nozzle at right with line oiler containing castor oil which cut down the dust content in air in a hematite mine in England from 2,500 particles per cc. to 250 particles per cc.


COMPRESSED AIR
MIST NOZZLE
LINE OILER
WATER
STANDARD LINE OILER FILLED WITH CASTOR OIL
USED TO ALLAY DUST AT ENGLISH HEMATITE MINE
(PRESENTED AT CONFERENCE ON SILICOSIS IN LONDON APRIL 1947)

NOISE

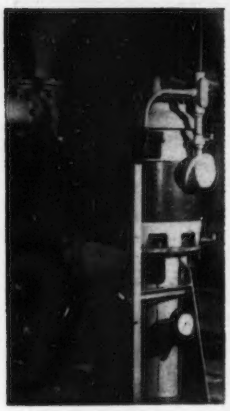
NOISE IS MORE than a nuisance. Scientific tests show that noise promotes fatigue, increases errors, and lowers output. To study the noise problem, Western Electric Co. has devised a meter which registers intensity of noise in decibels. (See table at right.) Note that the rock drill rates higher than the proverbial boiler factory.

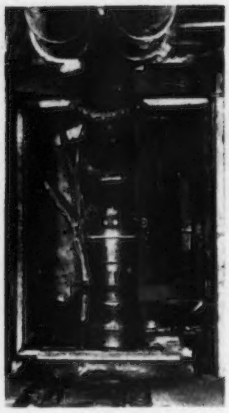
Manufacturers of rock drills have devised mufflers for certain drills, but report that drillers could not be induced to use them. Reason—The drillers felt that the machine was not working at peak efficiency unless it chattered noisily. One remedy might be the ear plugs illustrated, which stop loud noises and concussion, but admit conversational tones.

DECIBEL VALUE OF SOUNDS

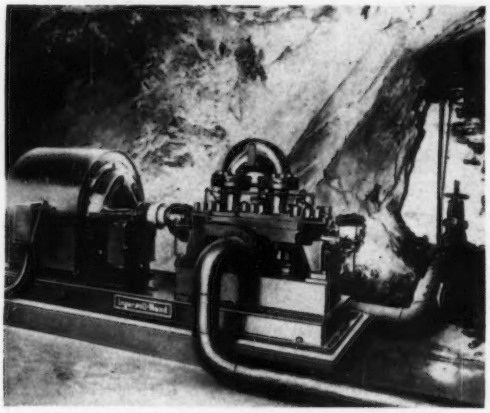
DECIBELS	TYPICAL SOUND
140	AIRPLANE ENGINE TEST CELL
130	ROCK DRILL
120	AUTO HORN
110	PUNCH PRESS, BOILER FACTORY
100	TRAIN PASSING SUBWAY STATION
90	NOISY FACTORY
80	AVERAGE FACTORY
70	
60	CONVERSATION
50	AVERAGE OFFICE
40	AVERAGE DWELLING
30	
20	AVERAGE THRESHOLD OF HEARING
10	
0	THRESHOLD OF ACUTE HEARING

EAR PLUGS stop loud noises but admit conversational tones.

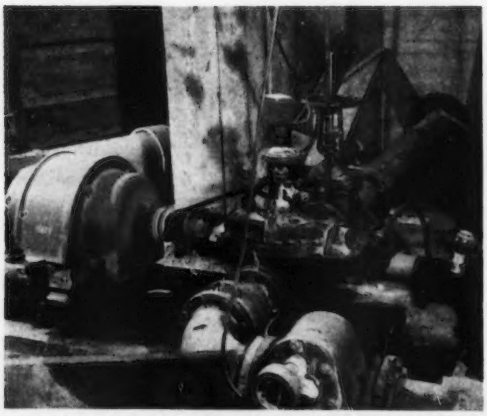




VERTICAL TURBINE TYPES. Pump at left has motor mounted on top of column; at right motor is submerged.



MODERN 6-STAGE CENTRIFUGAL in mine handles 1,110 gpm at 2,000-ft. head with 750-hp. direct-coupled motor.



CHEMICAL MINING (leaching in place) will need units like this which withstood acid water successfully for 5 years.

Pointers in Pumping

PUMPING IS OFTEN THE PRELUDE to production in large-tonnage operations. Arizona operators developing large caving blocks have had to sit around patiently for months waiting for the water table to be lowered by pumping before mining could start. In Canada an entire lake had to be pumped out at Steep Rock to permit open-pit mining. And in Nevada, Eureka is still striving courageously to solve its water problem in order to get at a bonanza ore deposit.

Paradoxically, whether plagued with a surplus or shortage of water, mines always have a pumping problem. The same companies in Arizona faced with a big drainage problem at one property may be faced with the problem of pumping water 16 to 18 miles over desert lines to supply a mill or cooling tower at another property. Recognizing this importance of pumping to production, it is essential that the most efficient units be selected for each job.

Vertical turbine pumps. A manufacturer of both vertical turbine and horizontal centrifugal pumps (Coal Age, July 1951) reports the following advantages for the vertical turbine type: Higher efficiency, lower power costs, less floor space, no priming equipment needed; turbine type can be adjusted more readily for abrasive wear without disassembling; motor can be installed on surface. Note in the two illustrations at left that motors can be mounted on top of the column or within the pumping column. Generally speaking, higher efficiency for the turbine type may be questioned. Nevertheless many mines are using vertical turbine types in large drill-holes and elsewhere to lower the water table in orebodies or above them.

Modernize your pumping stations. The Star mine in Idaho replaced 27-yr.-old centrifugals with improved modern models similar to the unit at left and saved $300 per month in power costs as a result of the change. (Compressed Air Magazine, October, 1950.)

Corrosion, one of the biggest headaches. Corrosion is being countered with rubber-lined, concrete-lined, stainless-steel, transite pipe, and stainless-steel pump parts. Liners are available in stainless steel to resist corrosion, and in silicon carbide to resist abrasion. (See E&MJ Dec., 1950.) Now that chemical mining (leaching in place) is increasing, more attention will be paid to pumping acid waters involved in such operations. See illustration at left.

Essentials of a good pumping station. (1) Install pump below sump to eliminate suction head and priming problems. (2) Provide auxiliary sump so that slimes can be removed (periodically) from main sump. (3) Provide small sludge pump to remove slimes from main sump to skip in shaft. (4) Arrange retractable by-pass in skip dump in headframe to permit discharge of slimes from skip. (5) Make sump big enough to allow pump repairs, or provide stand-by pump capacity.

Power transmission tips. Many new units have been introduced to regulate pump speed and transmit power to the shaft, including fluid clutches, magnetic clutches, automatic clutches and flexible couplings.

Looking ahead. Ore hoisting by pumping methods may be revolutionized by the "hydraulic material lift" developed by Percy Gardner (See E&MJ, Sept., 1950). This hoisting method is still under development, and well worth watching.

Modern Hoisting Trends

THE LOGICAL WAY to determine what's new in hoisting is to study installations made recently at major mining operations. A review of three important installations reveals the following interesting trends:

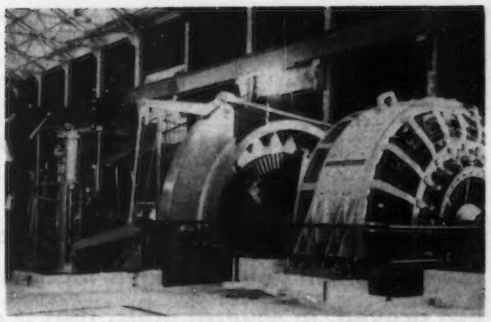
Greater Butte. In this $27-million project, the main ore hoist is double drum, 3,000-hp. (world's largest hoist motor), 12-ft. diameter, 8-ft. face, capable of holding 5500 ft. of 1⅞-in. rope in 3 layers. Rope speed is 2250 fpm. Skips will hold 12 tons with automatic bottom dump arrangement for faster unloading.

The hoist will be equipped with hydraulically-operated multiple-tooth clutch and brake. The d.c. motor will be 3,000 hp. Power will be supplied by a 2,500-kw. generator direct-connected to a 3,500-hp. synchronous motor. The 2,250-hp. cage double-drum hoist is also d.c. Both hoists have control equipment for automatic hoisting.

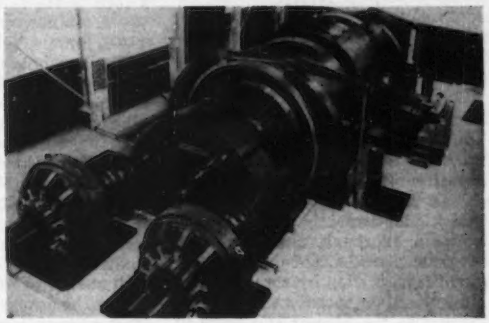
Kerr-Addison. This mine which has been called the "Homestake of Canada" because of its meteoric rise to a great gold producer, has modernized its plant for real production. Its hoisting plant (Canadian Mining Journal, Apr. 1951) uses both a.c. and d.c. power. The distinction is interesting. For ore hoisting where loads are lifted, the power is d.c., but for cage hoisting where the loads are generally lowered, the power is a.c. Details of the d.c. ore hoist are as follows: Double-drum, doubled clutch; total rope pull 85,000 lb.; speed 2,650 fpm.; depth 4,000 ft.; 15-ton ore skips; drums, 163 in. in dia., with 115-in. face, grooved for 2⅛-in. rope; drums controlled by expanding clutch keyed to shaft; brakes hydraulically operated; hoist powered by dual-drive 2,225-hp. motors through flexible couplings, each motor with a peak load rating of 4,500 hp.; power supplied by m-g set consisting of 5,000-hp. synchronous motor driving two 1,1750-kw. d.c. generators, one for each side.

The service cage hoist, which **lowers** men and materials, is a.c. powered and equipped with **dynamic brakes.** Similar installations have recently been made in Idaho, New York, New Mexico, and Pennsylvania in hoists ranging from 300 to 1100 hp. Briefly stated, **dynamic braking** takes the strain off of mechanical braking. This is accomplished at Kerr-Addison by feeding d.c. power to one phase of the stator windings of the a.c. hoist motor. This allows the hoist to be brought from maximum speed to creeping speed without application of mechanical brakes. Thereafter, mechanical brakes take over and hold the cage rigidly in place. Details of the Kerr-Addison cage hoist are as follows: Hoist is double-drum, single clutched, designed to operate at 2,000 fpm. to a depth of 4,150 ft.; rope pull is 33,100 lb.; drums are 10-ft. dia. 72-in. face, grooved for 1½-in. rope.; cage is keyed to shaft; counterweight is driven through toothed clutch; drive motor is 800 hp., wound rotor, 2,200-v. variable speed induction motor. After shaft is deepened to 4,000 ft., and hoist speed increased to 2,000 fpm., an additional 400-hp. motor will be installed. Direct current for dynamic braking is supplied by a 60 kw. m-g set.

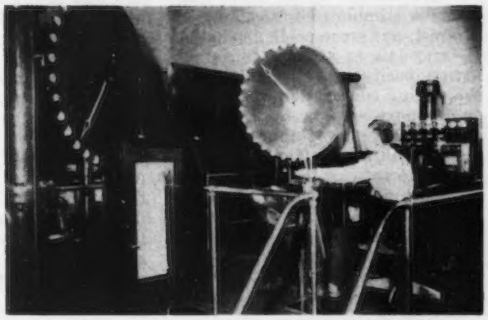
Potash Company of America. Although automatic mine hoists are not new, they continue to be of interest. One of the most recent installations is PCA's 1,000-hp. d.c. unit at Carlsbad, N. M. for hoisting 8-ton skips of potash at the rate of 1,500 fpm from a depth of 1,150 ft. The system includes an amplidyne exciter for the 750-kw. hoist generator.



GREATER BUTTE ore hoist is powered by 3,000-hp. d.c. motor.



KERR-ADDISON'S new twin-motored 4,500-hp. d.c. hoist and . . .



. . . new 800-hp. a.c. cage hoist wth dynamic braking

POTASH COMPANY OF AMERICA'S new 1,000-hp. automatic hoist.

How To Get More Tonnage Through Your Present Mill

Here are suggestions on increasing production with the equipment you now have, made by a man who has proved, in several mills, that it can be done.

J. J. BURNS
Mill Superintendent
St. Joseph Lead Co.
Balmat, N. Y.

THERE IS HIDDEN in most mills today a lot more capacity than the original designers planned on, or than capacity ratings for individual machines would suggest. To locate that hidden capacity and put it to work, a thorough and correlated program must be laid out and carried through, step by step.

First, the operators must be taken into the project and made to feel the urgency and the importance of what you are trying to do. They must be stimulated into taking an interest, and some pride, in the job. It is useless to attempt to get utmost capacity out of a mill without the willing cooperation of the men.

The next step is to forget the capacity ratings of the equipment in your mill, or any standard of output hitherto established, and push the machine to the limit. It might be well to warn the management ahead of time to expect some breakage, but if your plans are well-laid such things will be accepted in the light of the increased capacity you will achieve.

For example, if your primary crusher has a cast iron frame, you may break it by crowding the tonnage through it. But by that time, you should have built up a production record with which you can convince the management that you can buy a new cast steel frame and still be well ahead financially.

The Crusher First

As an example of what can be done, by following the practices outlined in the following discussion we have obtained an 11% tonnage increase from a gyratory at one of our mills, although it is now crushing much finer. Previously, it gave a feed to the rolls of 34.5% minus ½ in. It now provides a feed of 89.3% minus ½ in.

The crushing plant at this mill was in excellent shape and operating as efficiently as the average mill. When our work on it is completed, however, we hope to be able to do away with a third stage of crushing and still get a finer product plus increased capacity.

As a check on crusher plant performance, take samples for screen analyses of feed and discharge of each one. Also take power readings if possible. Ask the crusher operators to keep a record of all delays on each unit. For example, you may find that the primary crusher is delayed at times because the secondaries can't keep up with the primary.

If this is true, take up the primary discharge opening until the feed to the secondaries is fine enough so that they can keep up with, or better yet, outcrush the primary. After you have pushed the primary to the limit, you will find that the secondary crushers can then be tightened up, and in turn, a third stage, if you have it. It all adds up to a finer feed to the grinding plant.

Check Each Unit

After you have the whole crushing plant operating as a unit and at top capacity, you can start on the second phase of the job. This consists first of checking to see that all the units are in tiptop shape as regards bearings, eccentrics, mantles, concaves, etc.

Then go over each unit, not only with the idea of spotting bottlenecks, but to adapt the crushers to your particular ore and tonnage rate.

For example, one of the most profitable adaptations you can make is a change in the contour of the mantle in your secondary crusher. The manufacturer has to design a crusher to suit a wide range of feeds. He can't afford to make, and you couldn't afford to buy, a crusher custom-tailored to your conditions. But you can do a lot to make the crusher fit after you get it.

If you have tightened up the primary, your secondary, with a 7 or 8-in. opening, is probably crushing 2-in. ore, or some similar relationship of sizes. The result is a waste of the upper crushing zone and a heavy load on the lower zone.

That's why most secondary crushers show wear on their mantles as a kind of ledge or ring around the bottom part and no wear at all on the upper part. This condition decreases capacity and may even break a shaft if not corrected.

The usual procedure, which is absolutely wrong, is to build up, by welding, the lower worn zone to a point well beyond its original dimension in an attempt to compensate with thicker metal for the extra wear at this point.

The correct procedure is to build up the worn zone on the mantle to its original dimension, and then put a thicker weld on the upper, unworn zone ⅛-in. at a time. Observe the wear on the mantle thereafter, and keep increasing the thickness of the weldmetal on the upper part until a point is reached where the wear is uniform over the full length of the mantle.

If properly done, this operation will make the mantle last longer, crush more rock, crush finer, and save on power cost per ton.

Stop Screen Blinding

Blinded screens can cut capacity fast by keeping finished feed in circulation. If screens blind readily, it is better to sacrifice a few days' screen life and let the operators beat the screens with the most effective instrument they can find, short of a ball pein hammer. The increased capacity will more than compensate for shorter screen life.

Roy Yingling mechanized this screen-beating job at one plant some years ago by fastening heavy chains to the screen frames at the feed ends and letting them dangle down over the screen cloth. The

free ends, rattling about over the vibrating surface, kept the screens clear.

If the ore is particularly sticky and hard to screen, perhaps a slotted screen will help. The Tyler Co. is reported to have tried out a method of electrically-heating screen cloth wires, with good results in preventing blinding.

Watch The Rolls

If rolls are used in the third stage of crushing, make sure the roll faces are kept in good condition at all times and that no corrugations are allowed to develop. To keep roll faces in shape requires a close check on welding or the use of carborundum blocks, adjusted daily.

Study the causes of delay in the rolls circuit, as was done in the crushing plant. For example, in one mill the rolls were making an unusually fine product, which made it necessary to take up the rolls frequently. It was observed, in a study of delays, that it took five men to take up the rolls, and that the feed had to be shut off while it was done. Ball bearings were put into the roll take-ups, and thereafter two men could do the job and do it without shutting off the feed. There were 4 sets of rolls in this plant and the production thus saved was considerable.

I should like to stress one point in regard to the crushing plant, and that is, by all means continue to take samples of the various products for screen analysis. When the crushers are running at peak performance, such samples can be used for reference. Take new samples at least once a week for comparison with this standard. There is nothing like a comparative screen analysis to convince the repair foreman that there's work to be done on the crushers.

Grinding More Ore

Assuming success with the crushing plant, you should have a finer feed to the grinding circuit and should be able to handle an increased tonnage. However, there are certain well-recognized conditions that should be established in the grinding circuit to get maximum tonnage. In various papers, texts, and handbooks the questions of speed, ball or rod load, size of classifier, pulp dilution, etc., all have been dealt with exhaustively and there is no point in repeating the discussion here. One should simply check his own performance against these recommendations for whatever type of mill he has.

As one example, I might cite the papers written by E. J. Duggan describing his work with the Climax Molybdenum Co.'s grinding circuit. (A.I.M.E., T.P.) Few mills have as good a record of getting maximum tonnage through a ball mill as Climax, and their experience is worth listening to.

In any case, as the feed becomes finer, it is well to check on grinding circuit conditions to make sure that indicated changes are made. If you are using rod mills, you can increase their capacity by building up the rod load to about 55% of the volume of the mill. In adding rods, rotate the mill several times after each addition of ten rods. This avoids snarling up the rod load.

Also, for maximum capacity the smallest, well-worn rods ought to be removed once a week. To do this, rotate the mill before adding new rods, and as the thin rods come to the top of the pile they can be grasped with tongs and removed.

In the ball mills, one should be sure that he is not using too large a ball. The modern trend, and it is a good one, is toward smaller balls, and the finer feed from your crushing plant is right in line. Also, for increased capacity, the ball load should be increased. This can be done by giving the ball mill an extra charge of new balls each day until the smallest balls begin coming out of the discharge.

For Faster Flotation

Changes in operating technique, such as avoidance of spillovers and other troubles, can add to flotation capacity, but the biggest gains can be made simply by crowding the present cells to the limit.

For example, in one flotation circuit, 40% of the machines were shut down with no decrease in feed rate. This was done as a preliminary test to see what would happen when the mill tonnage eventually was increased.

The result has been a slightly higher grade of concentrate and a tailing assay as low as when all the cells were used. This was achieved simply by venturing beyond any previously accepted standards of capacity. The only reagent change used in this test was the addition of more frother to get a faster overflow.

As a matter of fact, it seems to me a good idea to operate the roughers with a fast overflow *at all times*. By so doing, an operator is free to give most of his attention to the cleaners, because he is protected against a high tailing due to a sudden increase in grade of feed.

Increase in pulp density is not a good way to try to increase flotation capacity. It may work out all right, but there is considerable danger of upsetting metallurgical results.

It is possible, of course, to increase flotation capacity by speeding up the impellers, blowing in more air, or installing more effective impellers. In one mill, tonnage in one flotation circuit has been increased from 500 tons to 1,275 tons. Part of this increase was due to installing larger blowers for the pneumatic cells used, but the greater part of the increase was due simply to crowding the machines beyond their rated capacity.

It should go without saying that the load on all the parallel units, in the crushing plant, the grinding circuit, or in the flotation section, should be equalized. At any rate, this point should be checked frequently and the distributors or the flowsheet corrected if unequal distribution is found.

Pumps, by the way, are usually run underloaded. If you have a poorly-designed pump box, you can get a definite increase in capacity by providing a properly-designed box. The pulp, especially in the flotation circuit, should be de-aerated. A long pump box will do it, one with the bottom and two of the sides sloping. Bring the pulp into the box as far away from the intake as possible.

If you are using a pump without a positive suction, you can flush solids into the pump with small hydraulic jets placed about 3 in. from the pump intake.

Don't Give Up

One thing to remember is that if you make a change in operation, if it is metallurgically sound and promises a reward of some proportions, don't be too ready to give up the test if the results you expect don't show up at once. Give the test at least a month's run, unless the losses are prohibitive. Give the operators plenty of time to adjust to the new conditions, and give the process itself time to become stabilized. Just make sure that your sampling and your system of mill reports are both adequate and accurate, and you can't go wrong.

PRODUCTION FOR DEFENSE—In the Mill

Check These Equipment Ideas For Greater Mill Production

Here are four pages of ideas that are now helping other millmen make their plants more productive

QUITE A FEW PEOPLE who read these words are going to take a quick look at that big ball mill down below, that even bigger rod mill up there at the right, and that outsize thickener, and they are going to say:

"Why tell me about an 11-ft. rod mill? That's nearly as big as our primary ore bin! What I need is a gadget that will squeeze out another 25 tons a day."

True enough. But whether you're treating 25 tons a day or 25,000, it's important for you to know about Tennessee Copper's ball mill and Consolidated's rod mill. Here are two good reasons why.

First, the things that are learned from those big mills are going to affect your operation, however small it may be. In fact, they may have already, in design of mill, size of balls, kind of alloy, or in the way you handle your grinding circuit.

Second, they prove to you that it is possible for a mill man to try something new and not be hanged for it.

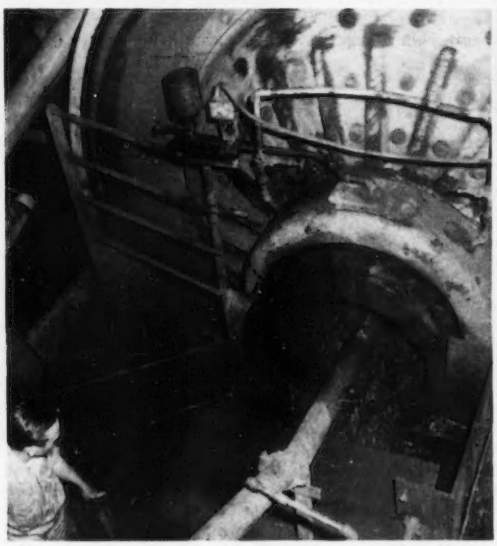
All these things started with an idea in a man's mind. Then, like you, because he didn't have unlimited funds to play with, he had to sell the idea to his management.

That wasn't done casually, in conversation, or by notes on scraps of paper. It was done by long study, careful analysis, calculation of costs, estimates of potential savings, made by several people competent to make them. All this went into reports that gave management the facts in understandable form.

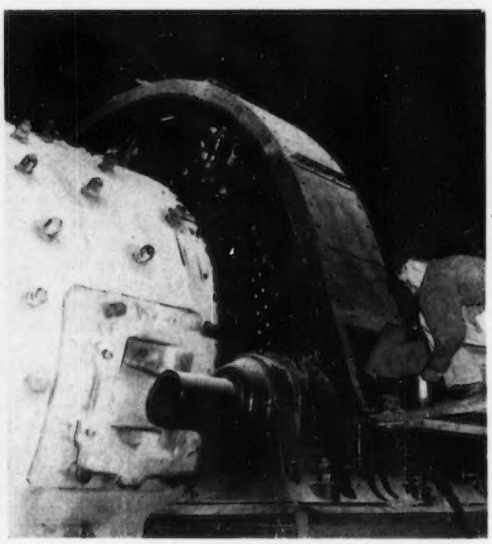
The reports didnt bury the point in a welter of screen analyses and percentages. They told clearly: 1, what the new item was supposed to do; 2, how much it would cost; 3, how much it would save over how long a period. Then the details were set down, if management wanted to check on them.

That's the lesson for this month. If, for example, you know you need better impellers in the flotation cells, it's your job to tell management about it. But it's also up to you to give them *all* the facts, clearly set down. Then they'll see it your way.

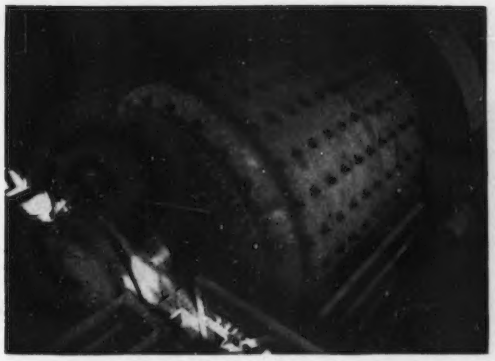
You can use larger units . . .



REPLACING 3 smaller mills, Tennessee Copper's Tricone ball mill, with 10-ft. Hydroscillator classifier, handles 2,200 tons rod mill discharge daily; saves 19.5% in power; cuts xanthate consumption 28.9%; copper sulphate, 29.1%, flotation time, 33.0%. Note water lubricated trunnion bearing.

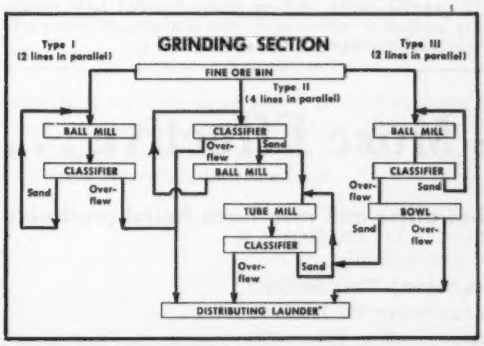


LONG-TIME USERS of rod mills, like Midvale, Hayden, and Tennessee Copper, must enjoy the swing to rod mills (above) as third stage of crushing instead of rolls. The latest on a growing list is a Midwestern lead-zinc mill which will use five 9x12-ft. rod mills for 15,000 tons.



CONSOLIDATED'S rod mill, 11x12-ft., Chapman Camp, B.C., crushes 7,500 tons daily of —1½-in. feed to 90% —6 mesh. Pulp density is 80% solids; speed, 18 rpm. (80% of critical); rod load, 76 tons of 3½-in. rods.

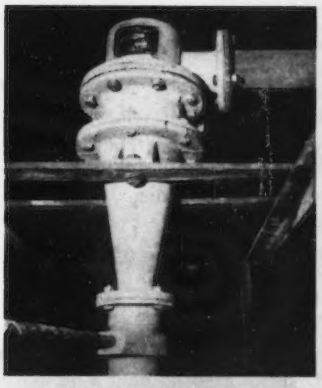
FIRST LINERS and lifters, like these, still good after 3.75 million tons; 10-in. rule, 3½-in. balls show scale. H. R. Banks, superintendent, cites high speed, high lifters, short compact rod mass, as factors in the mill's success.



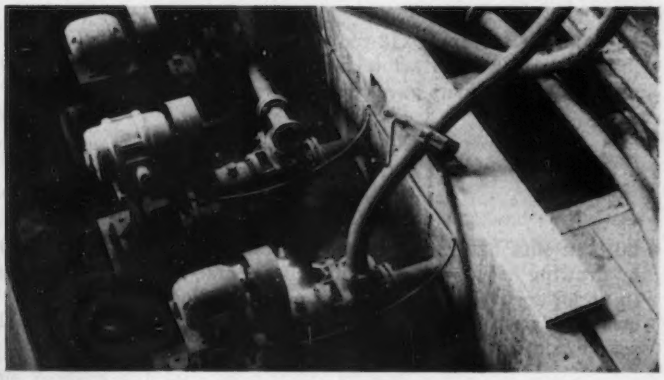
GRANBY increased total classifier width 83%, used new flowsheet (above), gained 5 to 10% mill tonnage. Rake return was increased from 1,100 to 3,400 dry tons daily.

MAMMOTH thickener handles —150 mesh slimes from 400 cu. yd./hr. Florida phosphate at Sydney plant. Basin is 750 ft., thickener mechanism, 300 ft., in diameter.

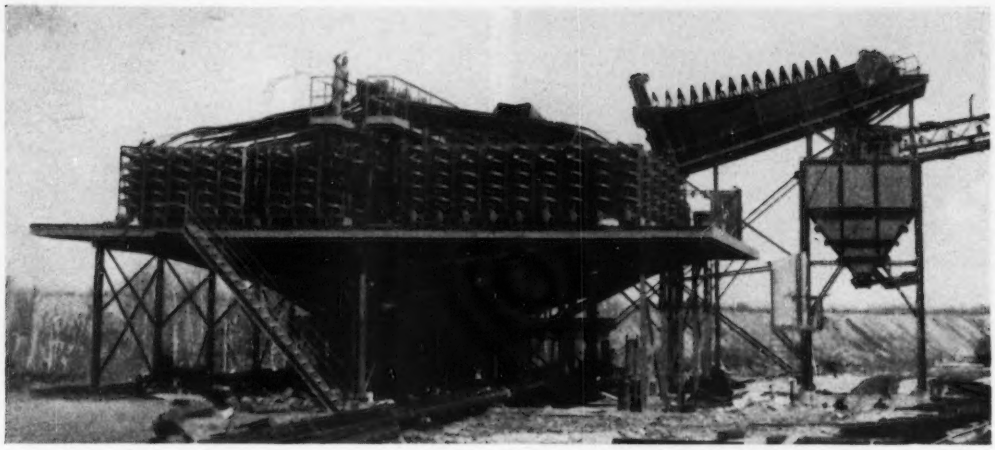
You can try something new . . .



DESLIMING at Telluride Mines with DorrClone saves 80% of gold formerly lost in slimes from a classifier. It treats 30 tons daily, returns 18 tons sand.



NEW PUMP LININGS can handle almost anything. Materials available include rubber, cement, various metal carbide mixtures, plastics, chrome-nickel iron, etc. These plastic-lined Wilfleys are pumping uranium leach liquors in Climax Uranium Co's Colorado mill. *(Continued on next page)*



READY SOURCES of iron ore are old tailings dumps on Minnesota ranges. Easily mined, material can be washed in Humphreys spirals, as in Patrick Plant of M. A. Hanna Co., agents, shown above under construction. Producing 75 tons/hr. of concentrates, it will use 144 roughing spirals, 72 cleaning spirals. Sixteen plants, totaling 1,528 spirals, are planned or operating on nine iron ore and iron washing plant tailings jobs here and abroad.

You Can Make Units More Effective . . .

By trying out some of these suggestions that other mill men have found profitable

● **FLOTATION MACHINES** are working harder than ever. The feeling's growing that intense agitation, with full aeration, can better the job done by long contact, with milder turbulence. For example, half a dozen cells supplying intense agitation have replaced twice the number of old-type cells in the roughing circuits of several Western mills.

● **ROD MILL FEEDERS** are troublesome at best. Lepanto Consolidated solved that problem with a short, fascinating belt feeder. It's 8-in. x 6-ft., throws feed at 600 ft./min., is driven by 2-hp., 440-v. motor.

● **NI-HARD LINERS,** in a 9x12 rod mill at J. & L's. Benson Mines, in a recent inspection showed 25% total wear after 19 months and 1½ million tons ground. Former liners gave out after 9 months on the same job.

● **WATER-LUBRICATED** bearings are coming around again. The Hardinge Co. puts them on its big new mills and the MacIntosh flotation machine is trying them in one location. Should be safer for flotation.

● **BUNKER HILL** has a good idea in keeping the mill heated evenly in winter by drawing hot air out of the top of the mill, filtering it, blowing it back in at lower levels. The old way, heating at bottom only, made top-side operators open windows, left downstairs operators freezing. The new set-up paid for itself in about 2 years.

● **WHY DOESN'T** somebody take a lease on some of those highly-pyritic tailing piles around the country, run them over a set of spirals, and sell the concentrate for its sulphur content?

● **IT'S WORTHWHILE** informing operators of what happens when a ball mill is allowed to run below capacity. Example: an 8-ft. ball mill normally took 35 3½-in. balls per shift; one operator began adding 45 per shift. It turned out he'd developed a habit of dropping feed back to 13 tons per hour to avoid throwing in a second filter.

● **THE INDUSTRY NEEDS,** says one operator, a secondary crusher in which centrifugal force aids the discharge, one which can handle finer and wetter ore. The old Symons vertical disk machine is an example. It is getting very low costs in the places where it is still used.

● **HARD-SURFACING** crusher rolls at Bonne Terre is a matter of mounting the roll in a slow drive on bearings, laying on weld metal with an automatic head. Puts on 90 lb. per shift; hand-welding could put only 25 lb. of ¼-in. rod on the rolls per shift.

● **TAILING PUMPS** at Bonne Terre have casings and impellers of chrome-nickel iron, hardness of 400 to 450 Brinell. Instead of machining them by grinding, they use a carbide tool, cutting speed of 70 to 75 ft. per min., and save 50% of machining time formerly required.

● **HOSES** or rubber-lined pipes, instead of plain piping, are turning up in more mills. Jack Myers puts steel fittings on them at joints simply by drilling small holes in the sleeve of the fitting and driving wood screws through the sleeve into the hose.

● **A MIXTURE** of silicon carbide and a ceramic material, developed by Norton Co., showed little wear after 520 days of service as pump housing handling a pulp that wore out all-metal housing in 61 days.

● **HOW BIG** can crushers get? One company has a jaw crusher 66x84-in. that's said to be able to handle over 1000 tons per hour.

● **YOU DON'T** have to buy another mill to get the advantages of a regrind on a bulk float. Bunker Hill's "flash" grind puts all the feed through the primary grind fast, floats out galena, from classifier overflow, de-sands lead rougher tails, puts sand back through primary grind. It cuts reagent cost, improves lead recovery and zinc grade.

● **METALLIZING** is easy, even in smaller shops. Earl Snodgrass, St. Anthony Mining & Development Co., Tiger, Ariz., gets 32 days' longer life out of pump shafts by metallizing. He says important point is to turn off rough cut on worn surface first. Makes sprayed metal stick.

● **PAINTED PIPES** in one mill help prevent embarrassing, and costly operators' errors. Yellow piping holds steam; green pipes carry warm water for pulp temperature control; blue pipes carry cold water; galvanized piping is for electrical conduits; red pipes carry reagents and pulp.

● **WOODEN WEDGES** in ore from square-set stopes, don't have to be picked out by a man on each shift. One Western mill puts its primary crusher discharge through a wide-mesh vibrating screen. The wedges are caught and discharged to one side into a wheelbarrow. Now if they could just mechanize the wheelbarrow!

Table 1. Calculations for Setting Up Quality Control Chart on Daily Production of Ore.

Metal Content, % (30 Days' Output)	Square of % Metal Content
9.13	83.3569
7.84	61.4656
10.28	105.6784
9.24	85.3776
7.68	58.9824
8.34	69.5556
7.01	49.1401
7.10	50.4100
7.99	63.8401
7.42	55.0564
7.73	59.7529
10.15	103.0225
7.64	58.3696
9.68	93.7024
8.24	67.8976
7.44	55.3536
9.03	81.5409
9.71	94.2841
10.21	104.2441
10.18	103.6324
10.31	106.2961
10.35	107.1225
8.73	76.2129
9.46	89.4916
9.04	81.7216
8.40	70.5600
6.38	40.7044
8.45	71.4025
7.76	60.2176
9.24	85.3776
259.76	2293.7700

Average — 8.67%

$$S = \sqrt{\frac{\Sigma X^2}{n} - \bar{x}^2}$$

$$S^2 = \frac{2,293.7700}{30} - 8.67^2$$

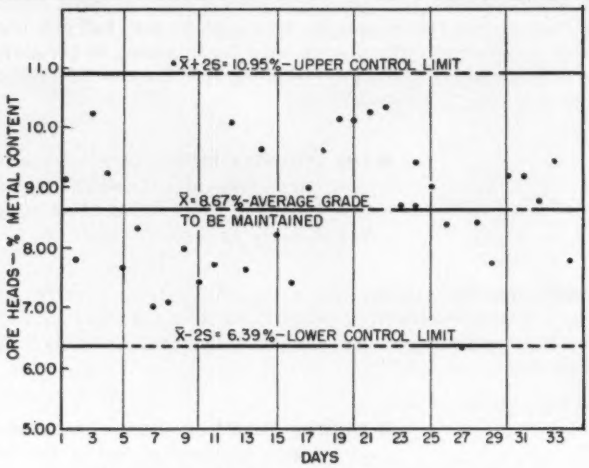


FIG. 1—This simple calculation (left) used to make the chart, is basis for quality control of mining or milling operation. This chart shows ore heads assays, indicates at a glance that production has average grade desired.

S = Standard deviations.
X = Assay each day.
n = No. of assays.
x = Avg. of assays.

Standard deviation 1.14%
Upper control limit $x + 2S = 8.67 + 2.28 = 10.95\%$
Lower control limit $x - 2S = 8.67 - 2.28 = 6.39\%$
$S^2 = 76.46 - 75.17$
$S^2 = 1.29$
$S = 1.14$

How To Use Quality Control To Improve Mill Production

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Statistical quality control is a fairly simply way of running a mining or milling process by substituting accuracy and certainty of control for guesswork.

There is nothing mysterious or complex about it. Most manufacturing or process industries learned a few years ago that certain elementary statistical methods could be used to check on, and to control, the quality of their output. These methods, referred to as "quality control," have saved these industries hundreds of thousands of dollars by preventing loss of time and money in making substandard products that had to be rejected. There is no reason why the same methods cannot be as useful in control of mining and milling processes as they are in manufacturing.

What Is Quality Control?

The fact is that for many years past, the mining industry has been gathering the basic data for setting up a quality control procedure, but has never made the best use of it. It is a rare mine or mill, indeed, that does not make provision for accurate sampling and assaying of its daily production of ores, concentrates, and tailings. But equally rare is the mine or mill that extracts all possible information from these data, gathered so carefully and expensively.

Common industry practice is to examine the daily shift assay re-

ports and to accept the performance they represent if the assays seem to be "in line." It is only when one or two shifts are obviously out of line that the supervisor is jarred into action. Or it may be that a persistent trend in some one assay over several days may cause an investigation of the operation.

In other words, the manager of the mine or mill has to depend on a kind of sixth sense, which admittedly some managers have developed amazingly well, to tell whether or not each day's results will fit into a pattern that at the end of the month or year will give him the average grade of ore, or mill products, that he has set as a standard.

Tells When To Act

Quality control, on the other hand, enables any supervisor to single out, at a glance and with certainty, those assays in each day's report that deviate too far from the standard. Quality control tells him *when* to act to correct the operation, and it goes a long way toward telling him *how*.

For example, suppose a mine management has set the cut-off point for grade of mine ore at 10% metal content. Obviously no one assumes that every carload of ore must run 10%. But the management does assume that the average grade of ore, over the time period it selects, will be 10%.

On a monthly basis then, each day's output need not assay 10%. In fact it would be needlessly expensive, and probably wasteful, to try to hit 10% each day. For maximum production from that orebody, all that is required is that the average for the month be held at 10%.

As each day's assays come in, deviating as they will from 10%, these questions come up: Are we taking too much waste from this stope? Or too rich an ore from that? Is this lean stope likely to run into better ore? Hadn't we better do closer sampling in that stope? What will it cost to step up output in this stope and cut back in that one? How much ore would we lose? What should we do about these assays, anyway?

The answer, under quality control, is probably that nothing need be done, *within limits*. Like the white lines on a highway, quality control marks the limits within which one can operate safely.

These limits are set up by statistical methods. They are based on the mine's history of production, into which all the idiosyncracies of management, engineers, miners, geology of the orebody, and technological developments have gone. Under these factors, the ore grade varies, and this variability is inherent in the process. It is only when the process itself changes that something need be done about it.

As long as the grade of ore each day is within allowable limits, based on past performance, the manager knows with a high degree of assurance that the cut-off point of 10% grade is being maintained. Mathematical exactnes has taken the place of opinion, and subjective guesses are replaced by scientifically gathered and evaluated evidence.

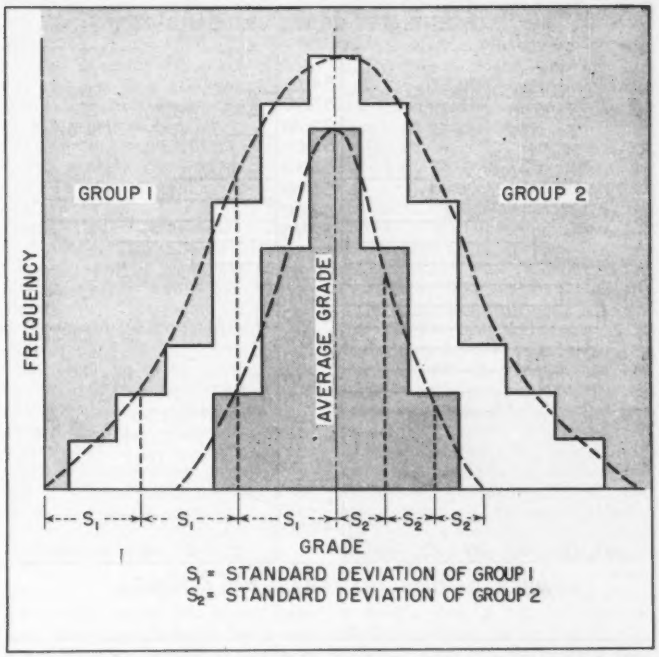

FIG. 2 shows how average can mislead. Groups 1 and 2 of above data have same average, but widely different spread.

Setting the Limits

An average is a common and useful statistic with which we are all familiar. But it does not tell everything about the group of data that is averaged. It merely tells one the central position of the data without giving any idea as to the spread of the data on either side of the average.

Statisticians have developed a value for expressing the degree of dispersion of the data that go into any average. It is called the *standard deviation*, and it is used in setting the limits referred to in the foregoing discussion.

The standard deviation is obtained by the following simple calculation:

$$S = \sqrt{\frac{\Sigma X^2 - x^2}{n}}$$

Where: S is the standard deviation.
X is the reading, in this case the grade of ore.
n is the number of such readings.
x is the average of the readings.

To put it another way, the standard deviation equals the square root of the average of the squares minus the square of the average. Table 1, to which we will refer later, shows this calculation carried out on actual ore head assays.

Having obtained the standard deviation, one can set the upper and lower control limits within which the operation has to be held. This is done simply by adding twice, or three times, the standard deviation to the average, for

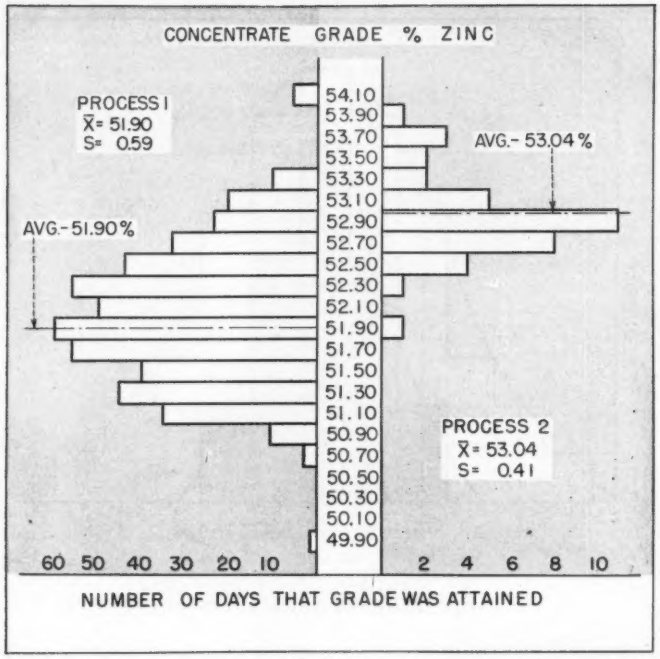

FIG. 3 compares concentrate grade of old Process 1 with new Process 2, but fails to give adequate evaluation. (Data from an actual operation.)

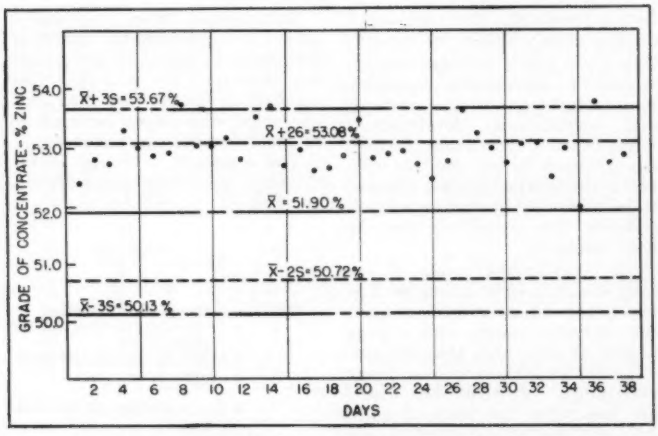

FIG. 4 shows how quality control chart, based on Fig. 3's data, readily proves Process 2 superior to Process 1.

the upper control limit (U.C.L.). The lower control limit (L.C.L.) is obtained by subtracting twice, or three times, the standard deviation from the average.

Thus, with the average and the standard deviation known, one can easily set the limits within which all the results of a process must lie in order that the average continue to be maintained at the desired point. Fig. 2 shows, diagrammatically, the spread of data in two processes, both with the same average but different standard deviations.

The mathematically-minded will observe that these limits are based on probability. Under any given set of conditions, the results of a process will vary from day to day according to the laws of probability. One can set the limits of the control scheme as widely or as narrowly as he likes. For example, if the upper and lower control limits are set by adding and subtracting three times the standard deviation, the limits will contain 99.7% of the results whose variation is due to the normal workings of probability. These are the limits indicated by the digrams shown in Fig. 2.

Therefore, normal variation would bring only 0.3% of the results outside the control limits. Because this probability is so small, one can assume that results outside the limits are caused by changes in the process that ought to be investigated thoroughly.

This means that investigations of the process are limited to those times when it is most likely that trouble will be found, and the cost of inspections is thus cut down.

For day-to-day control purposes, it seems preferable to use a factor of 2 in setting the control limits. This provides a 95% probability, which means that if one investigated every result lying outside the control limits, he would be right 95 times out of 100.

The Calculation

As an actual example, the cut-off point at a certain mine was about 8% metal content. To establish a quality control system, the assays of 30 days' production of ore were used as a basis (See Table I.). The average of these assays was 8.67%. The standard deviation, calculated by the formula given previously, was 1.14%. The upper and lower control limits, set by adding and subtracting 2.28% from the average, were 10.95% and 6.39%, respectively. The chart appears as Fig. I.

Thus as long as the head assay to the mill runs between 10.95% and 6.39%, all is well and no exhaustive stope sampling and inspection need be made. But if a 6%, or an 11%, assay shows up, something is wrong, and the ore and waste-handling procedures should be checked thoroughly. Since this thorough investigation is limited only to the time when it appears that something is wrong, it costs less than would a haphazard, or continuous, detailed investigation.

The millman really has a much more fertile field for use of quality control than does the miner. In fact, the range of use of quality

control in the mill is so wide because of the number of variables that the system can accommodate. However, until one has built up a fund of experience with quality control, it will probably be better to stick to less complicated applications of it. The following are examples:

Holding The Grade

At a certain small gold mine, a copper flotation concentrate was produced that could be made to run very high in gold content, or very low, depending on how the mill was handled. The company sold this concentrate to a Western copper smelter.

The smelter contract gave the mining company the greatest net return on this concentrate when it assayed 10 oz. per ton in gold. Therefore, the mill superintendent had the job of trying to hold each shipment as near 10 oz. as possible. This took almost superhuman alertness and the gift of prophecy, in view of the variations in grade of ore fed to the mill, and the vagaries of operator attentiveness and ability.

Quality control would have helped this superintendent tremendously. He could have told at a glance, from among the welter of shift assays presented him each day, which were danger signals and which were not. As it was, he wore himself out trying to keep *every shift* on the beam. This could be regarded as good training both for the superintendent and for the operators, but it is also true that a lot of this effort could, and should, have been avoided.

Blending of ores, before beneficiation, is one of the best ways to obtain optimum mill results. It may be that the heads assay each day is the best guide to whether or not the blending process is adequate. Or it may be that acidity of ore, percent of screen undersize, oxide copper content, or some other factor has been found by experience to be a better index to the quality of the blending job.

In any event, quality control charts, made up as already outlined, make it possible to tell with certainty whether the blending is satisfactory or not.

Metal recovery is also easily checked by quality control. It is a simple matter to select or to calculate a desired average tailing assay, and to calculate the standard deviation and the upper and lower control limits.

Having these values, one can use the resulting quality control chart in various ways. The most obvious value of the chart is that one can see at a glance not only how the mill's operators have done on the previous day, but how they have done for the past week or month as well. There is no need to refer to columns of figures, which are always hard to evaluate accurately in their inter-relationships. If a day's tailings assay reports too high, it will stand out on the quality control chart like a stop signal.

Conversely, daily tailing assays that are a little high, but not *too* high, show up in their true light on a quality control chart. Without the chart, one might be concerned enough about such borderline assays to go to work on the operators responsible, when actually it might be that nothing need be done. Quality control, in other words, tells one when *not* to act as well as when to do so.

The chart also helps answer the question raised by an occasional low tailing assay. Did it just happen, or does it indicate some unusual circumstance that ought to be investigated? If the assay lies below the lower control limit, one will be right 95 times out of 100 in investigating it. (If the lower limit is set at $x - 2S$.)

To Compare Processes

Evaluation of changes in milling practice is one of the most useful services of quality control. Unless the change under consideration results in a radical improvement, or decline, in quality of product, it is hard to evaluate the change accurately.

For example, a 1% increase in average grade of zinc concentrate is of great economic importance, yet it is small enough to be easily overlooked in a short experimental run. To show how quality control makes it easy to pick out such differences with assurance, the data plotted in Fig. 3 and Fig. 4 are given.

Fig. 3 shows that a great deal of the time the grade of concentrate made by Process 1 was the same as that made by Process 2, although the average for Process 2 (53.04%) was higher than for Process 1 (51.90%). The question arises, is Process 2 actually better than Process 1, or is the apparent difference owing to sampling errors, ore changes, shortness of run, or other factors?

Fig. 4 gives the answer. It shows quality control limits plotted on the average grade of concentrate of Process 1, based on a run of 502 days. On this chart are plotted the concentrate assays of a 38-days' run with Process 2.

All but one of the points of Process 2 lie above the 52% average, and some of them lie beyond the upper control limits of Process 1. This is evidence that Process 2 is different from Process 1.

Further, it was evident by the fourth day that a strong possibility existed that Process 2 is superior to Process 1, because that day's run lay beyond the upper control limit of Process 1. This made it a 95-to-5 bet that the improvement was *bona fide* and not random.

By the eighth day, one could have been certain of Process 2's superiority because: 1, all the points were on the upper side of the Proces 1 average; 2, the points cluster about the 2S limit of Process 1; 3, the eighth day is even beyond the 3S limit. Thus, in about a week's run, a 1% increase in grade is shown to be highly significant. One can be certain that the change in process *did* increase the grade of concentrate, and that the improvement was not due to chance.

Takes Further Study

These are only a few of the opportunities to make use of the recognized procedures of quality control in the milling process. Enough has been suggested to enable one who is unfamiliar with the technique to experiment with it. However, it is also suggested that anyone interested would do well to make a serious study of the mathematics and technique of quality control.

The authors wish to mention that the study of application of statistical quality control to mining began at the School of Mines, Columbia University. It is also being taught at the University of Alabama.

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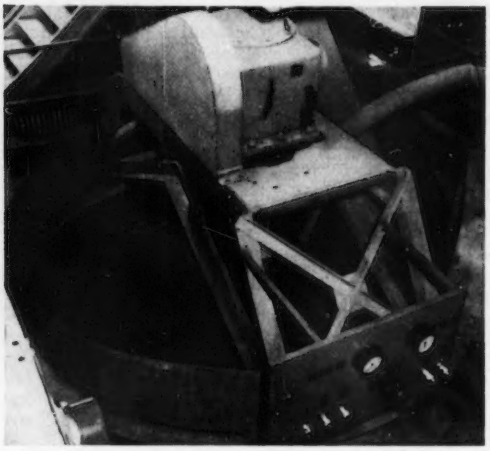
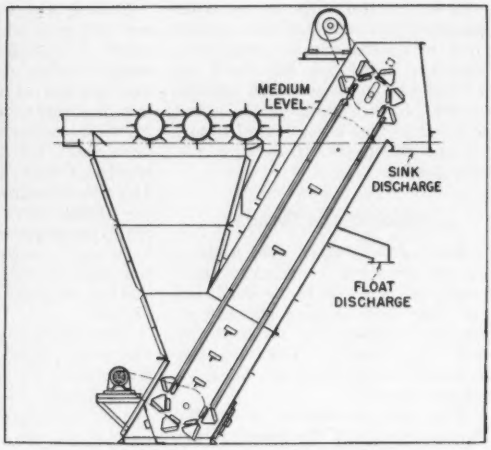


THE CONE, the original and still widely-used Heavy Media Separation vessel, gives superior metallurgy on close separations, but air-lift sink elevator plugs easily if major part of feed is sink product. This cone is handling fluorspar.



GALENA MEDIUM is used in this H. & H. separatory vessel. It gives cone-type performance, plus positive sink elevation. Note new feature of direct drive for bucket elevator's lower pulley; this was tested and is working well at Bunker Hill.

How New Units, New Uses Widen Scope Of Sink-Float

Quick question-and-answer survey on part latest sink-float developments can play in getting more production at lower cost

What processes are available?

Most widely used is the Heavy Media Separation process, licensed by American Zinc, with American Cyanamid Co. as technical and sales representative. Medium is usually ferrosilicon or magnetite, cleaned electro-magnetically. Also widely used is Sink-and-Float, or H. & H. process, licensed by Huntington & Heberlein of London. Medium is usually fine galena, cleaned by flotation or tabling. (See list p. 133.)

What equipment is available?

The H. & H. process uses one type of vessel, shown above at right. For the H. M. S. process one can use the standard cone, above left, with an air lift for elevating the sink product, or one can choose from the screw or drum-type separators shown opposite and on the next page. The cone's chief advantage is an ability to make a closer separation on difficult feeds than other types of vessel. Screw and drum types use less power, can treat coarser sizes, are easier to operate, and easier to start after shutdowns than H. M. S. cones.

What ores can be treated successfully?

Any ore in which: 1, there is a difference in sp. g. between ore mineral and barren gangue of at least 0.02; 2, the separation can be made at a sp. g. within the range of 1.25 to 3.40; 3, a valueless gangue is released by crushing to the size range, 5 in. to 10 mesh. (The cyclone, p. 132, may extend this range down to 48 mesh.)

Are sink-float plants hard to run?

No. Both galena and ferrosilicon medium plants have been run successfully by people with little or no previous milling experience, for example on old dumps and tailings. New equipment, shown on these pages, makes them even easier to operate.

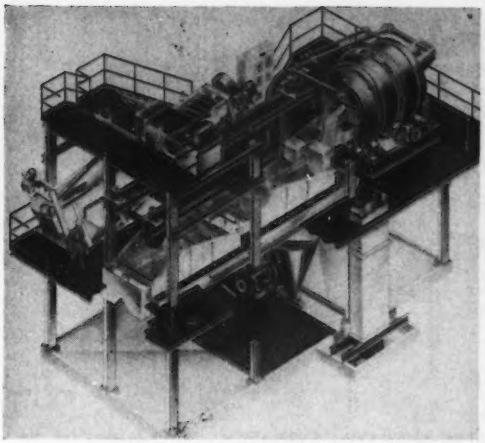
What does a sink-float plant cost?

As usual, the answer to this question is, "It all depends." But capital cost for this type of plant is lowest, per ton per hour treated, of any type of concentration process. For example, a 20 ton/hr. plant would cost around $100,000, pre-fabricated, that is.

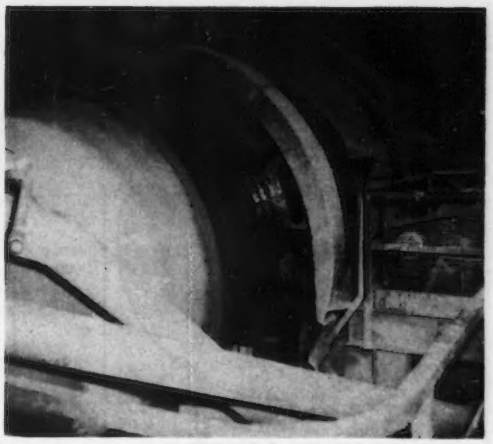
What is the operating cost of a sink-float plant?

The extremes are about 11c. per ton of feed for a large (600 tons/hr. or so) plant, up to around 40c.

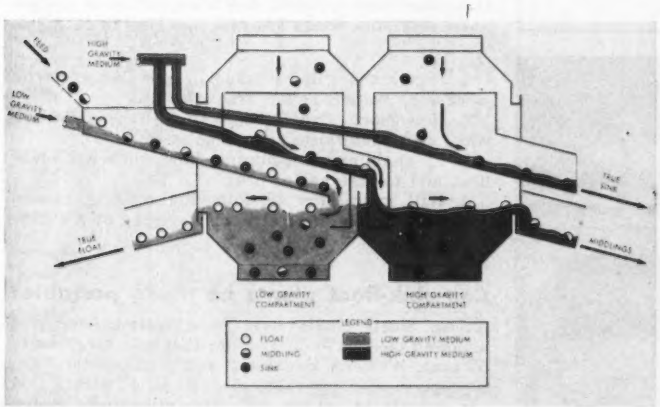
(*Please turn to p. 132.*)



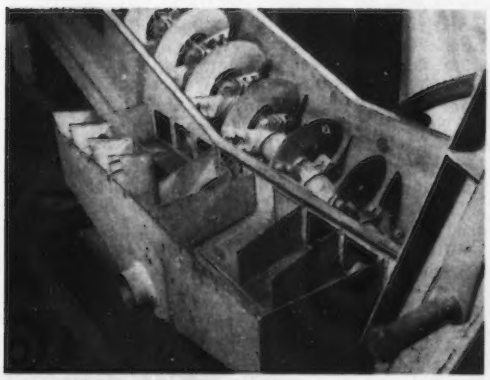
THE MOBIL-MILL (Western Machinery Co.) is used in over half the world's H. M. S. plants. With standard design, in several sizes, it's easily set up, runs economically. Note new drum separator, replacing cone because of ease of operation.



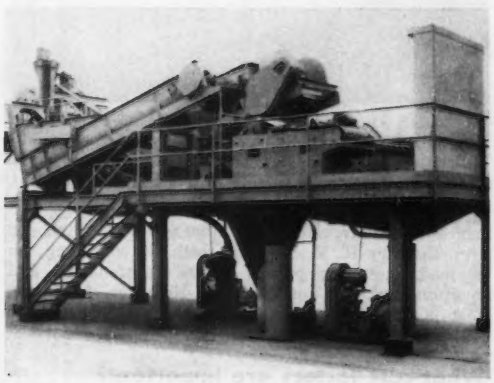
HARDINGE SEPARATOR, shown running in a Mesabi Range plant, is former classifier modified to suit H. M. S. work. It is a naturally good drum separator, is easily shut down or re-started, and is doing well in several iron ore production jobs.



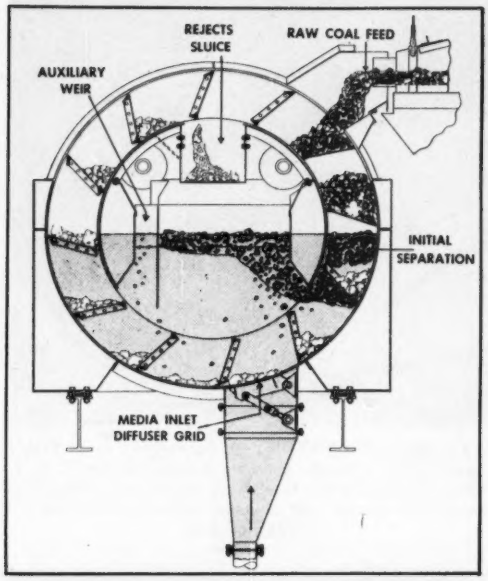
DOUBLE - DRUM SEPARATOR (Wemco's) shows one way to handle a middlings problem. First drum discards float, elevates sink and middling to next drum, where a higher-gravity medium floats away middling to be recrushed. This same job could be done with two cones in series, but transfer of sink and middlings would be much more difficult with air lifts between cones. Not all ores present a middlings problem, but some Mesabi iron ores have been found to do so.

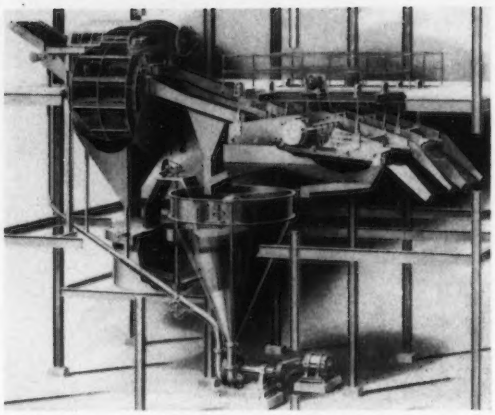


AKINS SEPARATOR (Colorado Iron Works Co.) was first device to replace cones for iron ore. It can make middling product where necessary. This is test unit in a Mesabi Range plant, set up to make iron ore middlings.

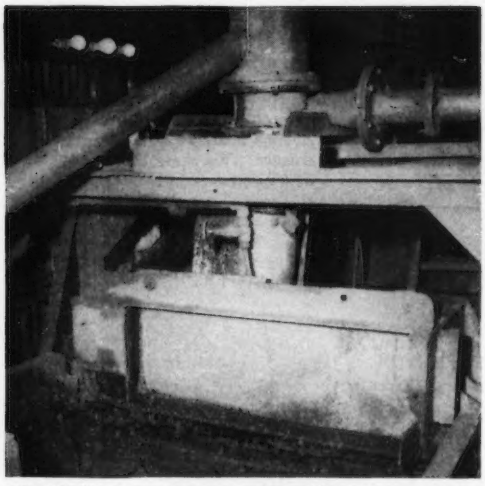


COMPLETE PLANTS, using Akins separator, are built by Southwestern Engineering Co., in 100 and 10-40 ton/hr. sizes. Pre-fabricated in shop, they offer savings, as do other such plants, in time and in erection and operating costs.





LINK-BELT CONCENTRATOR (above) is used for coal; could also serve for metallic ores. Pre-engineered, this unit uses a drum-type separator with feed introduced into interior pool, and rotation of drum's flights elevating the sink. NELSON DAVIS drum-type separator (left) is used with pre-engineered plants for coal treatment. Drum differs from other types in forcing feed below surface of medium where separation occurs and float then rises to discharge.



CYCLONE (licensed by American Zinc Co.) multiplies gravity differences in H. M. S. pulps, gives good results on iron ore in size range from 3/16-in. down to 65 mesh. This is test cyclone operating in a Mesabi Range plant.

per ton for certain small plants. One fair-sized Iron Country H. M. S. plant costs 22c. per long ton of feed, including power, labor, maintenance, and medium, but not amortization. However, operating cost is almost irrelevant in most sink-float plants.

What cost factors are important?

Far more important than operating cost in most plants are the savings and the increased production possible through sink-float. Against the first cost, or the operating cost, one should weigh these factors:

1. How much will be saved in grinding costs by discarding gangue at a coarse size?
2. How much greater capacity will the mill have when sink-float raises the grade of mill feed?
3. By enabling mass-mining, how much will sink-float add to reserves of ore?
4. Will metallurgy in following circuits be improved by discarding refractory gangue at a coarse size?

Can sink-float plants be made portable?

Yes. Small plants have been sectionalized and mounted on "low-boy" trailers that can carry up to 50 tons. Western Machinery and Southwestern Engineering offer pre-fabricated H. M. S. plants that can quickly be set up and dismantled for treating ore dumps in scattered locations. Huntington & Heberlein offer a similar pre-fabricated plant for galena medium.

But don't be misled by the portability feature, for example, the implication of Wemco's "Mobil-Mill" name. Mobil-Mills come in sizes from 5 to 420 tons per hour and up; only the smallest could be considered portable. The chief, and quite impressive, virtue of such pre-engineered plants is economy; of time, of design cost, and of construction cost.

Could sink-float plants be put underground?

No one has done it, but it would be a good idea. To the other savings made through sink-float would be added savings in hoisting costs. Float could be put right back into the stopes. Chief stumbling blocks have been pumping sink out of mine and dewatering, perhaps pumping, minus 10 mesh ore. These problems can be, and soon will be, solved. For example, note Percy Gardner's method of pumping ore out of a mine. (E. & M. J., Sept. 1950, p. 84.)

Here Are The Plants Using Dense Medium Processes

PLANTS UNDER CONSTRUCTION

Company	Location	Vessel Used	Capacity T/hr.	Size Feed	Separation Gravity
IRON ORE					
Shook & Fletcher Supply Co.	Russellville, Ala.	Wemco drum	75	3x⅜-in.	.....
Coons-Pacific Co.	Virginia, Minn.	Wemco drum	150	1½x¼-in.	.....
Hanna Ore Mining Co.	Keewatin, Minn.	Hardinge	400	.....	.....
Sloss-Sheffield Steel & Iron	Jefferson Co., Ala.	Akins	100	.....	.....
Schroeder Co.	Russellville, Ala.	Wemco drum	120	1¼x⅜-in.	.....
Cleveland-Cliffs Iron Co.	Michigamme, Mich.	Wemco drum	125	¾x2.5 mm.	.....
Mesaba-Cliffs Mining Co.	Taconite, Minn.	Wemco drum	200	1x2.5 mm.	.....
Cleveland-Cliffs Iron Co.	Nashwauk, Minn.	Akins		.....	.....
DIAMONDS					
Con. Diamond Mines	Orange Mouth, S. W. Africa	F. & C. cone*	80	.....	.....
Forminiere	Belgian Congo	Wemco cone	50	.....	.....
LEAD					
St. Joseph Lead Co.	Bonneterre, Mo.	H. & H. cone	85	1¼x6 M.	2.54
Cie. Aramayo, S.A.	Animas, Bolivia	Wemco cone	25	2 x10 M.	.....
LEAD-ZINC					
Cie. des Mines D'Ouasta	Algeria	Wemco cone	40	.....	.....
Combined Metals Red. Co.	Pioche, Nev.	Sweco-Akins	50	+8 M	2.85
Kootenay Belle Gold Mines	Sandon, B. C.	Wemco cone	25	.....	.....
Soc. F. des M. du Blaynard	Blaynard, France	Wemco drum	25	25 x1.7 mm.	.....
Van Roi Con. Mines, Ltd.	Silverton, B. C.	Wemco drum	25	1½x6 M.	.....
Western Exploration Co.	Silverton, B. C.	Wemco drum	25	2 x½-in.	.....
Canada Metals Co.	Sandon, B. C.	Hardinge	...	.....	.....
L'Union Miniere Pyrenes	Sentien, France	Wemco drum	20	25 x8 mm.	.....
MANGANESE					
African Manganese Co.	Natuta, Gold Coast	F. & C. cone*	100	¼x48 M.	2.73
Central Provinces Man. Ore Co.	India	Wemco drum	100	5 x½-in.	.....
CHROMITE					
Rhodesia Chrome Mines	Selukwe, S. Rhod.	F. & C. cone	35	1½x20 M.	.....
TIN					
Cie. Aramayo, S.A.	Oploca, Bolivia	Wemco cone	33	2 x10 M.	.....
Cie. Aramayo, S.A.	Caracoles, Bolivia	Wemco cone	15	3 x½-in.	.....
Cie. Aramayo, S.A.	Chorolque, Bolivia	Wemco cone	15	2½x10 M.	.....
BRUCITE					
Basic Refractories, Inc.	Gabbs, Nev.	Wemco cone	50	.....	.....

PLANTS NOW OPERATING

IRON ORE					
Butler Bros. (Patrick)	Cooley, Minn.	Hardinge	360	1½x¼-in.	2.8–3.2
Butler Bros. (Harrison)	Cooley, Minn.	Hardinge	260	1½x½-in.	2.9–3.2
Mesaba-Cliffs Min. Co.	Calumet, Minn.	Hardinge (coarse)			
		Akins (fine)	300	1¼x½-in.	2.9–3.1
Rhude & Fryberger	Ironton, Minn.	Wemco cone	100	¾x½-in.	2.8–3.1
Mesaba-Cliffs Min. Co.	Taconite, Minn.	Akins	440	.....	2.9–3.2
Pacific Isle Min. Co.	Leetonia, Minn.	Hardinge	50	1¼x½-in.	2.8–3.2
Stanley Mining Co.	Biwabik City, Minn.	Akins	126	¾x½-in.	3.1–3.25
Sloss-Sheffield S. & I. Co.	Franklin Co., Ala.	Wemco cone	75	2 x10 M.	2.55–2.65
Algoma Ore Properties, Ltd.	Sault Ste. Marie, Canada	Hardinge	120	1½x10 M.	3.10–3.20
Hanna Ore Mining Co.	Coleraine, Minn.	Akins	190	1½x¼-in.	2.9–3.2
Lone Star Steel Co.	Daingerfield, Tex.	H.M.S. cone	150	2 x½-in.	3.0

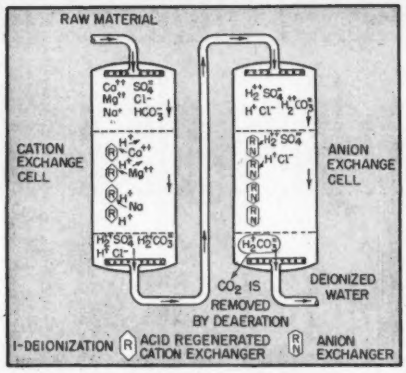
* Fraser & Chalmers, Johannesburg, S. Africa.

Company	Location	Vessel Used	Capacity T/hr.	Size Feed	Separation Gravity
Inter-State Iron Co.	Buhl, Minn.	Wemco drum	150	1½x⅜-in.	3.0–3.2
Hanna Coal & Ore Corp.	Ironton, Minn.	Wemco drum	135	2 x½-in.	.....
Zontelli Bros.	Ironwood, Mich.	Wemco drum	100	1¾x½-in.	3.0–3.2
Shook & Fletcher Supply Co.	Russellville, Ala.	Wemco cone	100	4 x½-in.	2.80
Stripa Gruv.	Ludvika, Sweden	Wemco cone	50	50 x 5 mm.	3.20
Inter-State Iron Co.	Calumet, Minn.	Hardinge	340	1¼x⅝-in.	.....
Cleveland-Cliffs Iron Co.	Coleraine, Minn.	Hardinge	250	1½x½-in.	.....
Georgia-Alabama Ore Co.	Bluffton, Ala.	Wemco cone	40	3 x¼-in.	.....
W. S. Moore Co.	Virginia, Minn.	Wemco drum	150	2 x½-in.	.....
LEAD					
Halkyn Dist. United Mines	Halkyn, England	H. & H. cone	20	1 x⅜-in.	2.76
Linton Mines	Bonita, Mont.	Wemco cone	35	3 x6 M.	3.15
Soc. des Mines d'Aouli	Midelt, Morocco	H. & H. cone	45	1 x½-in.	2.73
ZINC					
American Zinc Co. of Tenn.	Mascot, Tenn.	H.M.S. cone	165	2 x¼-in.	2.73
Bolaget Vieille Montagne	Ammeberg, Sweden	H. & H. cone	45	2 x⅜-in.	2.75
LEAD-ZINC					
Eagle-Picher M. & S. Co.	Cardin, Okla.	H.M.S. cone	400	1½x⅜-in.	2.69–2.84
Bunker Hill M. & C. Co.	Kellogg, Ida.	H. & H. cone	135	1¼x6 M.	2.73
Consol. M. & S. Co.	Chapman Camp, B.C.	H. & H. cone	425	2½x4 M.	2.98
Kootenay Belle Gold Mines	Kaslo, B.C.	Wemco cone	40	1½x8 M.	2.80
Yale Lead & Zinc Mines	Ainsworth, B.C.	Wemco cone	20	.....	.....
Corp. Min. Castrovirreyna	Peru	H. & H. cone	10	2 x6 M.	2.80
Soc. Min. del Predil	Predil, Italy	H. & H. cone	65	1¼x½-in.	2.85
Soc. Min. Montevecchio	Sardinia	H. & H. cone	45	1¼x½-in.	2.75
Soc. Min. Montevecchio	Sardinia (Ponente)	H. & H. cone	45	1 x½-in.	2.85
Soc. Ital. Piombo e Zinco	Nossa, Italy	H. & H. cone	15	1¼x½-in.	2.80
Soc. Min. de Penarroya	Sardinia (Buggeru)	H. & H. cone	5	2 x½-in.	2.80
Soc. Min. de Penarroya	Sardinia	H. & H. cone	15	1¼x½-in.	2.80
Soc. Mines de Zellidja	Fr. Morocco	Wemco cone	50	.....	.....
FLUORSPAR					
Rosiclare Lead & Fluor.	Rosiclare, Ill.	Wemco cone	35	⅞x¼-in.	2.62–3.10
Alcoa Mining Co.	Rosiclare, Ill.	Wemco cone	15	2 x10 M.	2.60
Inland Steel Co.	Marion, Ky.	Wemco cone	17	2 x6 M.	.....
Kentucky Fluorspar Co.	Marion, Ky.	Wemco cone	17	.....	.....
Davenport Mines, Inc.	Marion, Ky.	H. & H. cone	10	1½x½-in.	2.70–2.95
Crystal Fluorspar Co.	Elizabethtown, Ill.	Wemco cone	25	1½x10 M.	.....
Newf. Fluorspar, Ltd.	St. Lawrence, Nfld.	Wemco cone	15	1 x10 M.	.....
Glebe Mines, Ltd.	Eyam, England	H. & H. cone	17	1 x⅝-in.	2.82
Glebe Mines, Ltd.	Eyam, England	H. & H. cone	10	1 x⅝-in.	3.2
TIN					
Cia. M. de Colquiri	Colquiri, Bolivia	H.M.S. cone	40	1½x⅜-in.	2.65
Patino Mines & Ent.	Catavi, Bolivia	H.M.S. cones	125	1½x–1 mm.	2.64
DIAMONDS					
Premier Diamond Min. Co.	Cullinan, S. Africa	F. & C. cones	768	1 x10 M.	2.90
Anglo-American Corp.	Kimberly, S. Africa	F. & C. cone	15	.....	.....
Williamson Diamonds, Ltd.	Tanganyika	F. & C. cone	30	1 x10 M.	3.00
Manitoba Prov. Govt.	Rivers, Manitoba	Wemco cone	75	1½x10 M.	2.4
MISCELLANEOUS					
Lithium Corp.	Rapid City, S. D.	Wemco cone	12	+10 M.	.....
Benguet Consol. (chrome)	Philippines	Sweco-Akins	40	4 x4 M.	.....
Rhodesia Chrome Mines	Selukwe, S. Rhod.	Akins	15	¾x¼-in.	.....
Vereeniging Brick (andalusite)	Vereeniging, S. Africa	F. & C. cone	8	⅝x30 M.	.....
Northwest Magnesite Co.	Chewelah, Wash.	Wemco cone	145	1¼x½-in.	2.98
General Refractories	Radenthein, Austria	Wemco cone	60	1 x10 M.	.....
Canadian Refractories, Ltd.	Kilmar, Que.	Wemco cone	40	1½x⅜-in.	2.7
Barton Mines Corp. (garnet)	North Creek, N. Y.	Akins	25	1¼x⅜-in.	3.38

Look To New Ideas And For Greater Production

PROCESS | HOW IT

Ion Exchange Resins



Ion exchange resins are similar in action to zeolites used in common household water softeners. Zeolites pick up calcium and magnesium ions in exchange for sodium ions, and can be regenerated with a strong salt (NaCl) solution.

The resins are much more durable (they can be expected to serve 20 years with no chemical degradation), have a higher capacity and some of them can be quite selective.

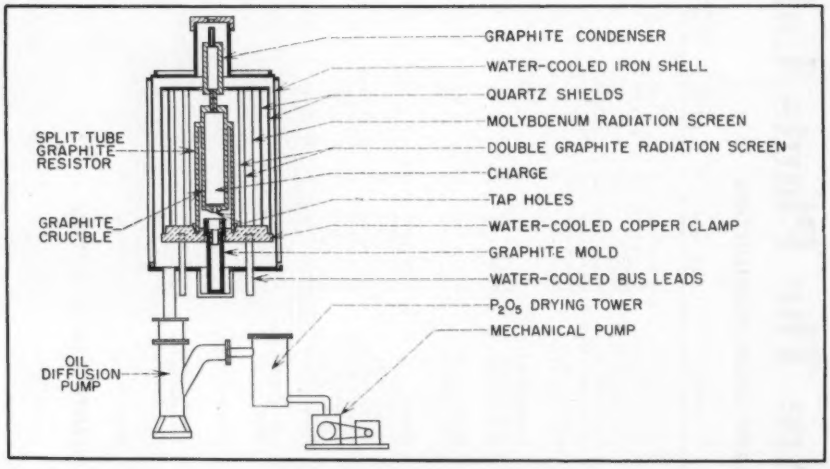
Resins are porous, resinous structures. The long organic chains are cross-linked so that they are practically insoluble in common solvents. To these chains are attached active groups such as $(-SO_3)^-$ or $(-COO)^-$. As the resins are received, these active groups are satisfied with hydrogen or sodium which they will exchange for metal cations if conditions are right.

You could also have active groups such as $(-NH_3)^-$ which would pick up anions.

A combination of anion and cation exchangers will make an ideal water softener. You can trade H^+ for cations such as magnesium or calcium and trade OH^- for anions such as CO_3^{--}.

Activity of the resin is not confined to the surface of the particles; the structure is sufficiently porous to permit access of ions inside the grains. The resins can be regenerated with acids or salt solutions at which time the metal ions are released.

Metallurgy Vacuum



Inverted Blast Furnace

The inverted blast furnace is essentially a conventional furnace with the bosh inverted so that the walls taper from a large diameter to a smaller diameter at the top. The result is improved smelting operation primarily because the reverse slope of the walls offers no surface for the accumulation of accretions. Further, you obtain a larger circumference, to put in a greater number of tuyeres. With the decreasing diameter of the bosh, the velocity of the upward flowing gases through the central section of the furnace is also increased.

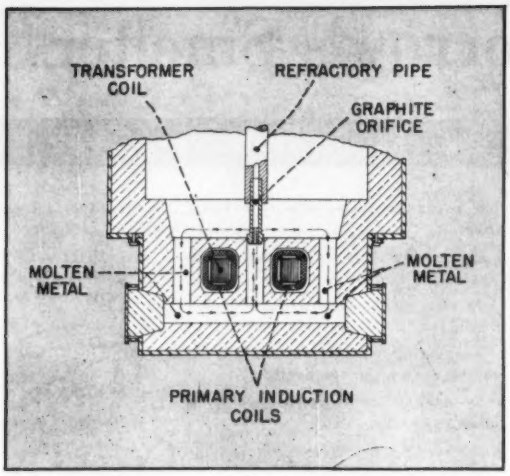
Combined effect of these improvements is that dead spots are eliminated and smelting proceeds more rapidly, thereby increasing furnace capacity. Smelting takes place in the lower part of the furnace at all times rather than getting progressively higher, a problem in most standard

New Processes Like These From Tomorrow's Smelters

WORKS	WHAT'S DOING NOW	POTENTIALITIES
Some resins, like the carboxylic, are quite selective and will pick up a particular ion in preference to others. The order of selectivity cannot be predicted exactly and is best determined experimentally. An ion exchange resin can be used for metallurgical purposes in several ways. (a) To collect metal ions in exchange for Na or H. (To remove undesired metal ions.) (b) To collect metal ions which can be recovered upon regeneration (concentration). (c) To collect a variety of metal ions and there obtain a separation when they are released in succession upon elution. (Concentration plus separation.) (d) To selectively pick up a metal ion from a variety of ions. (Recovery or purification.)	**Ion exchange resins are now being used in:** Recovering copper from rayon mill wastes. Separating the rare earths in fission products. Recovering copper from dilute wash solutions at leaching plants. Producing de-mineralized water in place of distilled water. Recovering silver from photographic film wastes.	**In the future, ion exchange resins may well be used for:** 1. Difficult separations such as zirconium from hafnium or columbium from tantalum. 2. Recovery of metals from mine waters. 3. Recovery of metals from industrial wastes. 4. Recovery of magnesium and other metals from sea water. 5. Purification of solution prior to electrolysis. 6. Recovery of rare metals such as germanium.
If a metal compound when reduced, yields a metal vapor or some other gaseous products (such as CO or CO_2), the use of a vacuum will permit the operation to be conducted at a lower temperature and go more nearly to completion. Metal produced will be protected from oxidation. If metals are distilled in vacuum, they will be protected from oxidation and the rate of distillation will be much higher than under atmospheric pressure, permitting satisfactory operation at lower temperatures. High vacuum is obtained by (1) mechanical pumps alone; (2) mechanical pumps plus diffusion pumps; and (3) steam ejectors. Furnaces can be heated from the exterior with gas, oil or electricity as in orthodox magnesium retorts or dezincing kettles. Alternatively, electric heating units can be used inside the vacuum furnace permitting larger units.	**The principles of vacuum metallurgy are now used in:** 1. Well known reduction of calcined dolomite with ferrosilicon to give magnesium. 2. Reduction of CaO with Al to give calcium. 3. Reductions to give strontium, barium and lithium. 4. Dezincing of lead bullion. 5. Dezincing of brass scrap.	**Outstanding possibilities for the application of vacuum metallurgy include:** 1. Carbon reductions of refractory metal oxides. 2. Separation of metals. 3. Purification of metals. 4. Direct reduction of metal sulphides. 5. Production of metal powders by distilling amalgams. 6. Metal plating in very thin layers.
blast furnaces. Less coke is needed and walls are subject to less wear. A further improvement incorporated in the inverted bosh is the installation of tuyeres perpendicular to the walls of the bosh. This places them at a slight incline into the furnace, decreasing the likelihood that they will be filled with slag.	At present an inverted blast furnace is at a small copper scrap smelter on the Eastern Seaboard. A standard furnace was originally performing unsatisfactorily. The bosh was removed and inverted. Result: the daily capacity of 35-40 tons was raised to 110-120 tons; coke consumption was reduced from 25% to 10% of charge.	The lead industry, as the only large-capacity user of blast furnaces in the non-ferrous field, might well consider the possibilities of inverting the bosh. To date, high capital costs have made operators reluctant to put money out for such a revolutionary idea, but its advantages should make it catch on before long.

PROCESS	HOW IT

Electro Magnetic Pump



Several types of electromagnetic pumps are manufactured. This type is made by Ajax Engineering Corp.

Two primary induction coils on a common laminated transformer core, operating from a 60-cycle a.c. power supply, induce high currents in the 2 loops or channels of molten metal. These act as the closed single-turn secondary coils of a tranformer. Currents of both loops combine in the common center channel which carries a current of the order of 30,000 amps. This center channel current is surrounded by its own magnetic field, with flux lines forming essentially concentric circles. In accordance with the 3-finger rule, all forces in the liquid conductor are directed toward the center of the circular cross-section, resulting in a maximum of electromagnetic pressure there.

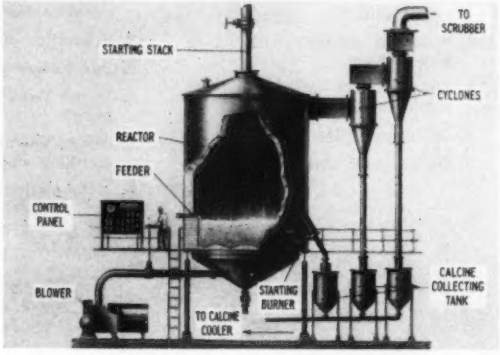
A graphite orifice connects to a pipe made of silicon carbide refractory

Flash Smelting

Treating flotation concentrates directly in the smelter is not new, but the use of oxygen in that connection is an interesting novelty. While virtually nothing has been published on the process, it is said to be essentially a spraying of concentrates into the furnace along with considerable oxygen, as much as 0.2 ton per ton of concentrate. Smelting of the fine particles takes place almost immediately, perhaps before they hit the hearth of the furnace.

Saving in fuel is noted as the primary advantage of the process. In addition, sulphuric acid and other sulphur-containing by-products can be produced on a larger scale.

Fluo Solids



Fluo-Solids is a process of fluidizing a mass of granular solids. The nature of the phenomenon can best be understood by describing the transition of a static mass to a fully fluidized condition. Picture a mass of granular solids ranging in size from minus ten mesh down to a few microns; such a material as dry, bank-run sand with only the very coarse fraction screened out. This mass partly fills a bin with a perforated bottom. Beneath it is a chamber into which air can be forced, with exit only upward through the sand.

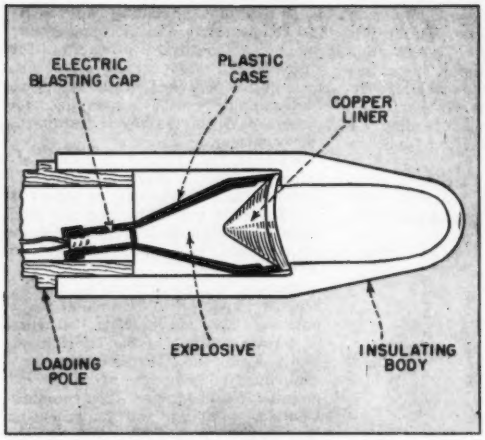
Such a mass of sand would be slightly permeable. If a small amount of air were admitted to the chamber beneath the bin, it would pass upward, with no resulting disturbance of the sand, with slight back pressure. As the rate of air flow gradually increased the first noticeable result would be a gentle lifting or expansion of the entire sand bed, still without surface disturbance. Back pressure against the air would rise slowly to maximum intensity until, quite suddenly, gentle spouting would develop all across the surface of the sand bed.

As the rate of air flow increased, the sand mass would expand still more and the spouting, now more vigorous, would extend across the entire surface of the bed. The sand mass, now fully fluidized, would occupy perhaps 25% more volume than when at rest. Any large stones which might have lain on its surface at first would now sink quickly to the bottom; and any lighter submerged objects, such as blocks of wood, now would float. If it were a mass of white sand originally, with a thin covering layer of red iron oxide, almost instantly the entire mass would become pink by admixture.

A substantial amount of dust will be swept out of the bed by the fluid-

WORKS	WHAT'S DOING NOW	POTENTIALITIES
which leads the molten metal to a mold or casting machine. Above the metal level the pipe is heated by electrical elements which keep it at the temperature of the molten metal. The size of the orifice determines the rate of flow. Molten metal is contained in a refractory-lined hearth above the induction unit which acts as a reservoir. The electromagnetic pump thus combines functions of a pump and a holding furnace. Varying voltage on each coil permits close temperature control of metal held in the reservoir while not pumping. By energizing both coils with full current for a time interval governed by an electric timer, controls enable repeated pouring of specific amounts of metal whenever released by a push button or limit switch actuated by a casting machine.	**Electromagnetic pumps** have been used principally in production of aluminum die castings. Heretofore hand ladles were used. Besides eliminating this manual labor, it can determine a precise time cycle; it delivers metal of a closely controlled temperature, homogeneous alloy assured by internal circulation, and free from surface slags. Other uses include casting of small ingots and aluminum shot. The unit has also been used for pumping zinc.	**With pumping rates** on the present industrial unit adjustable up to 18,000 lb. per hour, the electromagnetic pump might be useful in smelters for circulating a wide variety of metals, including copper and brass. It might, for example, be used in pumping copper matte from the reverberatory to the converter. While a fair volume is easily attained, inherent characteristics will probably limit pressure to about 2 psi. In other words, it does not lend itself to lifting molten metals more than a foot or two above the level held in the reservoir. Because of high currents used, some heat is imparted to the metal while pumping. This can be controlled within certain limits. On the other hand, under some conditions as high as several hundred degrees of superheat may be obtained, and this combination of pumping and superheating may invite new applications of the electromagnetic pump.
	This process was developed by International Nickel Co. primarily for use in treating copper-nickel ores. Low-cost production of oxygen goes hand in hand with the development of this process and Inco has constructed just such a plant at Copper Cliff. Plants of this nature may be able to turn out a satisfactory grade of oxygen for as little as 20 cents per ton.	**Already Canadian Industries, Ltd.,** has announced plans to build a plant at Copper Cliff that will produce 90,000 tons of liquid sulphur dioxide a year from the gases developed by Inco's flash smelting process. In these times of sulphur shortage, this by-product incentive may soon induce smelters carrying on similar operations to investigate flash smelting as a source of additional profit as well as a saving in fuel.
izing gas. There may be no particles capable of settling, individually, against the gas stream, but many particles coalesce and drop back to the bed, as if flocculated in the dry state. This is fluidization. In its application to the roasting of sulphide ores, for instance, the solids are a flotation concentrate and the fluidizing gas is air. Advantages of the process are that there are no moving parts, so that maintenance is nil. All metal parts are protected by refractories. Because of intimate admixture and perfect contact between solids and gases, chemical efficiency is high and uniform temperature control throughout the bed is easily maintained. In shutting down, cooling rate with a good refractory is low. At Campbell Red Lake in a 75-ton roaster treating 25 tons per day, cooling rate of the bed when shut down each day at 1250° F is 12° F per hour. It is easily started, without preheating, after 48 hours. Composition of the fluidizing gas being easily controlled makes the process extremely flexible.	**Limits on the application** of Fluo Solids are: (1) Particles coarser than minus 10 mesh require excessive amounts of air; (2) if all particles are too fine, the fluidizing gas will channel; (3) if materials must not become sticky at high temperature. The process is currently being used in the calcination of limestone and roasting of auriferous sulphides. **PLANTS IN OPERATION:** Cochenour Willans, Red Lake, Ont. Campbell Red Lake Mines, Red Lake, Ont. New Dickenson Mines, Ltd., Red Lake, Ont. Golden Cycle Corp., Cripple Creek, Colo. New England Lime Co., Adams, Mass. Barton Mines Co., North Creek, N. Y. Copper Range Co., Freda, Mich. (Pilot plant) Anaconda Copper Mining Co., Anaconda, Mont. (Pilot plant) **PLANTS ON ORDER:** The Brown Co, Berlin, N.H. Aluminum Co. of Canada, Arvida, Que. U. S. Bureau of Mines, Boulder City, Nev. Union of South Africa, Johannesburg, S.A. Helenic Co., Oxea, Greece. Giant Yellowknife Gold Mines, Ltd., Yellowknife, N.W.T. Negus Mines, Yellowknife, N.W.T. National Mortar & Supply Co., Gibsonburg, Ohio. (Fluo-Dry)	**Present indications** are that the next field to be invaded by solids fluidization equipment is the burning of pyrite. The next step, the real technological pioneering, will lie in the utilization of reactions (and perhaps materials) now commercially useless. For instance, virtually all common metals are attacked at fairly low temperatures by chlorine and rendered water-soluble. Chlorine in a Fluo Solids roaster, which is refractory-insulated throughout and gas-tight, invites speculation on application to mixed concentrates; dead roasting, selective reduction, and chlorination. Probably from a tonnage standpoint the process presents opportunity for hitherto sub-grade solid fuels. As a fuel, a sulphide concentrate with 18% sulphur for wet feeding, or even less for dry feeding, is satisfactory. There must be many comparable fuels, locally available. There are dozens of other applications from simple drying of surface moisture to high temperature calcining where Fluo-Solids can play a part.

What Smeltermen Are Talking About



● **JET TAPPING** is a development by Republic Steel Corp. for its open-hearth furnaces. The Jet Tapper provides a good, clean, fast tap without heavy labor, and since it operates by remote control, no one is placed in an exposed position. A uniform full flow of metal is obtained right from the start and skull production has been decreased.

The Jet Tapper is a small shaped charge containing 2 oz. of a relatively insensitive explosive enclosed in a bakelite case. This is set in a hollow insulating body with walls ½ in. thick. A special high-temperature blasting cap fits snugly in the rear of charge. The insulation is sufficient to prevent the cap from being detonated by the furnace heat for a minimum of 3 minutes. The loading pole is made of cardboard tubing.

When the charge is detonated, the explosion causes the copper liner around the tapper to collapse progressively from apex to base, squeezing a jet of copper particles from the inner surface of the cone. These particles, reaching speeds up to 30,000 fps., penetrate the facing of the tap hole. The action takes place in a matter of microseconds. As the explosion is heard, a full stream pours into the ladle.

● **STRONTIUM** is AS&R's patented answer to the problem of lead contamination in the production of electrolytic zinc. Added to the electrolyte in the form of a strontium carbonate slurry at the rate of 45 lb. $SrCO_3$ per ton of cathode zinc produced, tests showed a reduction of Pb content in the cathode of almost 90%.

In practice at AS&R Co.'s Corpus Christi plant where the process was developed, only 2.2 lb. of $SrCO_3$ slurry is added per ton of cathode. Average lead content of cathode zinc was reduced from 0.0037% to 0.0015%, well below the maximum permitted by Special High Grade specification.

Beyond inhibiting lead contamination, there are indications that conducting electrolysis in the presence of strontium may afford other advantages, such as electrode position at considerably higher temperatures and increased current efficiency.

Patent rights are held by AS&R.

● **ZINC CASTING WHEEL** at American Zinc's Monsanto plant is awaiting the completion of equipment for handling dross, but experimental work with the unit has been satisfactory.

Molten zinc is syphoned through a Pyrex glass tube into a graphite ladle which is mounted on a hanger so that it can follow the mold on the wheel.

Limiting factor of casting wheel operation is cooling of the slab, accomplished by water sprays on the bottom of the molds.

Zinc slabs are removed from the wheel by a vacuum suction cup actuated by an air cylinder. Slabs are stacked by a lifting device in one-ton piles on a straight-line conveyor.

Vibration is kept from becoming a serious problem by careful balance of the wheel.

American Zinc believes that the casting wheel will take away a large part of the manual labor associated with the casting of zinc slabs, and effect some labor saving in handling the dross.

Up at Trail, B. C., too, mechanical casting will be a part of plans in expanding the zinc plant to give it 66 tons a day additional capacity. Intentions are to install a 300-ton low frequency induction furnace for melting cathodes.

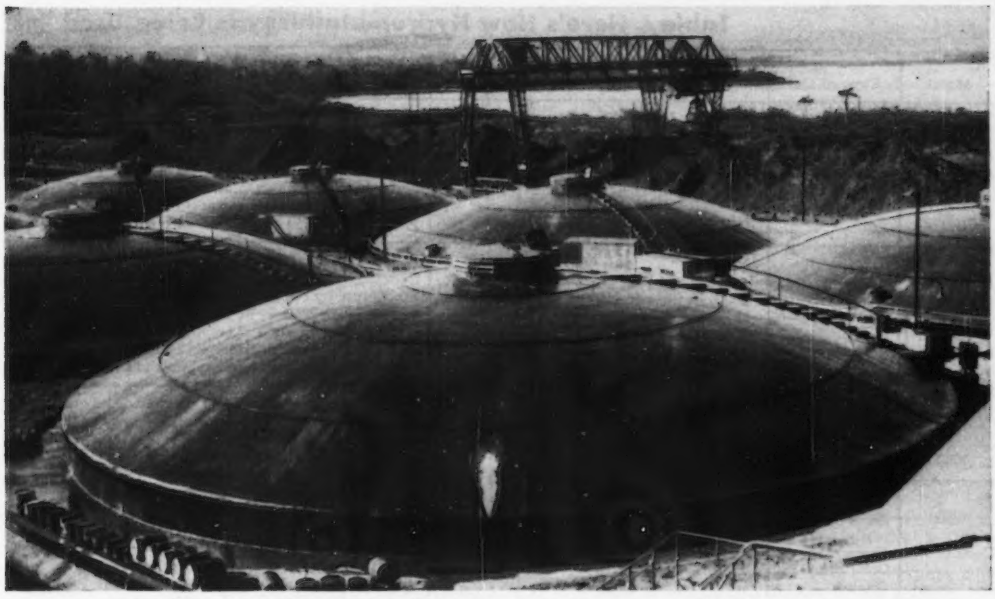
Lead casting at Trail is already mechanical.

● **AUTOMATIC TUYERE PUNCHING** is being tackled by more and more smelters in an effort to eliminate an uncomfortable and somewhat dangerous job. Along with Kennecott's unit, which has been discussed in the literature, are efforts by both AS&R and Falconbridge. Design in all cases calls for air-operated punchers, with the chief modification being the design of the puncher itself. Kennecott's unit uses the puncher as a piston to clear the tuyere. Other units under test use a piston arrangement to strike the puncher. Length of stroke and frequency depend on the converter design and practice.

● **CONVERTER PRACTICE** may soon be put on an automatic basis so that operators will not be dependent on the art of the converter foreman. Noranda is working on the problem now. Flux is already being fed automatically and air-control units have been installed. They are working on temperature control now and will eventually install automatic tuyere punchers. The results they are after will place control of converter operation in the metallurgist's office.

This practice is perhaps more applicable and more desirable in Canadian smelters, where converters are worked hard and emphasis is placed on a high output rather than conserving the life of the converter, as in the U.S.

● **TANK LININGS** in electrolytic plants have come in for considerable experimentation in recent years. Corpus Christi has done work with acid-proof brick, Trail is using vulcanized rubber linings, and other plants have done work with Proderite (hot-pitch concrete) tanks which require no lining. Good results under severe conditions in the chemical industry have spotlighted the possibilities of several plastic linings, with polyethylene and Teflon offering the most promise to the electrolytic plants. Lead-lined concrete tanks are still the mainstay of most plants, but the wave of experimentation indicates that a more satisfactory solution is desired.



AMMONIA LEACHING of complex nickel ore in these covered tanks at Nicaro Nickel Co., Cuba, illustrates trend toward hydrometallurgical treatment of low grade and refractory ores.

Tomorrow's Mines Will Depend Heavily On Leaching For Strategic Metal Production. That's Why It's Important To Know . . .

What The Future Holds For Hydrometallurgy

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HYDROMETALLURGY can't help but play an important role in supplying metals for defense. For one thing, improvement in equipment and techniques bring the process back in the competitive spotlight. For another, it may be the only key to some of the strategic minerals whose only domestic occurrence is in low grade ores. The trend toward leaching is clearly marked, both by an increase in operating plants and in numerous reports of research and development for hydrometallurgical treatment of ores and concentrates.

To illustrate: In copper, the Greater Butte Project in Montana is reported to be developing a leach-precipitation-flotation process for recovery of oxidized copper; Cyprus Mines on the island of Cyprus has developed a similar process for the same purpose; the White Pine Project in Michigan is studying the advisability of leaching and electrowinning of copper from flotation concentrate as a substitute for smelting; Sherritt-Gordon, at Lynn Lake, Man., is considering the leaching of a copper-nickel-cobalt concentrate by am-

FIG. 1. The five typical flowsheets of leaching processes.

Liquid "Ore"			Solid Ore	
I	II	III	IV	V
Precipitation	Leaching	Concentration	Thermal pre-treatment	Concentration
	Precipitation	Leaching	Leaching	Thermal pre-treatment
		Precipitation	Precipitation	Leaching
				Precipitation

Table I. Here's How Hydrometallurgy Is Being Used For

Metal	Type of Ore	U. S. Production	Type Flowsheet	Description
Aluminum	Bauxite (imported & domestic)	100% of U. S. Production. About 3,°00,000 long tons of Bauxite treated in 1950.	II	Pressure-digestion of bauxite with caustic solution. Precipitate pregnant solution by cooling and crystallization.
	Bauxite	Used to some extent in Europe.	IV	Sinter bauxite with soda ash. Leach sinter with water. Precipitate pregnant solution with carbon dioxide.
Antimony	Tetrahedrite (Idaho)	Not used at present. Operated during World War II, at about)000 tons Sb. per yr.	III	Leach concentrate with caustic-sodium sulphide solution. Precipitate by electrolysis in diaphragm cells.
Beryllium	Beryl	100% of U. S. Production of Be and Be-salts, by these, and one other similar process. 3,000 tons of beryl processed in 1950.	V	Hand-cobbed crystals of beryl are ground and sintered with sodium ferric fluoride. Sinter leached with water. Precipitate beryllium hydroxide by pH control.
	Beryl		V	Hand-cobbed crystals of beryl are melted and quenched. Ground beryl-glass is heated with sulphuric acid and leached with water. Beryllium sulphate is recovered by evaporation and crystallization.
Cobalt	Cobalt-bearing pyrite (Pa.)	Close to 100% of cobalt recovered from U.S. ore. 800,000 lbs. of Co in 1950.	V	Concentrate is calcined, then re-roasted with salt. Leach with water. Precipitate pregnant solution by pH control.
	Cobaltite (Idaho)	Under development. Projected capacity of 3,000,000 lbs of Co in 1953.	III	Pressure-digestion of cobaltite concentrate with ammonia & oxygen. Precipitate pregnant solution with CO or H_2 under pressure. } Surmised Method
Copper	Mixed oxide-sulphide porphyry (Arizona)	In 1947: 33,960 short tons of copper produced, or 4.6% all copper recovered from ores, tailings, etc.	II	Leach ore with acid ferric sulphate solution. Precipitate pregnant solution by electrolysis (part by cementation).
	Mixed oxide-sulphide (Nchanga, N. Rhodesia)	Projected flowsheet; 5,000 ton/day of ore.	III	Sulphides are concentrated by flotation and smelted. Oxides are concentrated by flotation and leached with sulphuric acid. Precipitate pregnant solution by electrolysis.
Gold and Silver	Siliceous	In 1948: 13.8% of total gold and 1.3% total silver produced in U. S.	II	Leach ore with dilute sodium cyanide and air. Precipitate pregnant solution with zinc metal.
	Gold bearing pyrite]		V	Roast pyrite concentrate. Leach the calcine with dilute soldium cyanide and air. Precipitate pregnant solution with zinc metal.

monia under pressure; newly developed oxidized and semi-oxidized copper ore-bodies in the Southwest, as well as the oxidized copper in porphyry flotation tailings, are causing renewed interest in leaching in that section.

In nickel the Nicaro Plant in Cuba will reopen to recover nickel oxide and possibly cobalt, from a laterite ore by ammonia leaching.

In cobalt both the Blackbird Project in Idaho and Rhokana in Northern Rhodesia are developing processes for leaching flotation concentrates.

In tin the Vulcan Detinning Company in New Jersey has been operating a plant to recover tin from cassiterite concentrate by reduction roasting, followed by leaching.

Leaching of tungsten minerals is an integral part of U.S. Vanadium's process at Pine Creek, California.

Uranium and vanadium recovery and separation at Monticello, Utah, are based on leaching. The listing is not exhaustive, but it illustrates the renewed interest in hydrometallurgy.

Classification of Hydrometallurgical Processes

Two component processes of hydrometallurgy, leaching and precipitation, have manifold application in the recovery of metals. (In this article we are concerned with hydrometallurgy only in its role as the **primary** extractive process for the recovery of values from ores and concentrates.)

Where hydrometallurgy is the primary extractive step for severing values from ores, five type-flowsheets summarize current practice. (Fig. 1.)

Flowsheet I represents the special yet important case of the recovery of values from naturally occurring aqueous solutions. Nature has already performed the leaching step, usually associated with hydrometallurgy, in the formation of natural brines and sea water. For example, the primary extraction of magnesium from sea water involves only simple precipitation of magnesium hydroxide with hydrated lime. (Subsequent treatment of the magnesium hydroxide precipitate is for the purposes of purification and conversion to a chemical form which can be easily reduced to the metal, hence is not part of primary extraction.)

Primary Extraction Of Metals*

Metal	Type of Ore	U. S. Production	Type Flowsheet	Description
Magnesium	Sea water.	In 1950: 100% of U. S. production; 15,750 short tons of metal.	I	Precipitate magnesium hydroxide from sea water with hydrated lime from oyster-shells.
Manganese	High-grade MnO_2 (imported)	In 1948: 100% of U. S. production of *pure* Mn°; 2,300 tons	IV	Convert MnO_2 to MnO by reducing roast. Leach with sulphuric acid (spent electrolyte) which contains ammonium sulphate. Precipitate by electrolysis in diaphragm cells.
Nickel	Nickel-bearing iron-laterite (Cuba)	Will reactivate in 1951. 16,000 tons of Ni°, yearly capacity; 12% of total U. S. imports.	IV	Nickel silicates reduced to the metal with producer gas. Leach with aqueous ammonia and air. Precipitate pregnant solution by distillation of ammonia.
Tin	Cassiterite (imported from Bolivia)	A small fraction of total U. S. production of tin.	V	Convert concentrate to metallic tin by reducing roast. Leach with caustic solution. Precipitate by pH control (surmised).
Tungsten	Scheelite, Wolframite, etc.	100% of U. S. production of *pure* WO_3 and *pure* W°. In 1948: 3,350 tons of concentrate treated.	V	Fuse concentrate with soda ash. Leach with water. Precipitate with calcium, chloride or by pH control.
	Scheelite + Powellite (Calif.)		III	Pressure-digestion of concentrate with caustic solution (nature of leach solution surmised). Precipitate calcium tungstate from pregnant sol.
Vanadium, Uranium, and Radium	Carnotite (Utah)	These leaching methods, and other similar ones, account for 100% of Uranium and Radium recovery and a large fraction of Vanadium recovery.	IV	Roast ore with, or without, salt. Leach with hot soda-ash solution. Precipitate by pH control.
	Patronite (imported from Peru)		V	Roast to remove sulphur. Leach with sulphuric acid and precipitate by evaporation; or leach with caustic and precipitate by pH control.
	Pitchblende		V	A variety of processes is used, which involve fusion with sodium salts, followed by leaching and precipitation.
Zinc	Sphalerite	In 1948: 40% of U. S. primary zinc: 312,500 short tons.	V	Roast sphalerite concentrate to the oxide. Leach with sulphuric acid (spent electrolyte). Precipitate pregnant solution by electrolysis.

* This table is meant to be illustrative of present hydrometallurgical practice and is not an exhaustive survey. The material included under "Description" gives only the major dissolution and precipitation steps; the purification steps are omitted.

Flowsheets II through V, for the treatment of solid ores, each contain the essential sequence leaching—precipitation. They differ in the presence or absence of one or both of two preliminary steps—ore concentration, and thermal pretreatment of ore or concentrate.

Direct leaching of the raw ore or concentrate (Flowsheets II and III) is commonly used where the valuable minerals are readily soluble in inexpensive leach solutions. Preliminary concentration (Flowsheet III) is usually preferable to Flowsheet II when the ore is susceptible to inexpensive dressing methods, since the reduced bulk of material means a saving in equipment and reagents may be realized. Oxidized copper-ores are directly leached (Flowsheet II) where physical concentration is not practical. Bauxite is also directly leached because the ores treated are already high-grade and dressing would be of little value. Siliceous gold ores are directly leached because ore-dressing methods could not realize the desired recovery of precious metal.

In many cases the valuable minerals in the ore are so refractory to dissolution that they must be converted to a readily soluble form by thermal pretreatment; in such cases either flowsheet IV or V is employed. Again, flowsheet V will be preferred over IV when the ore is susceptible to inexpensive dressing methods.

The use of thermal pretreatment on raw ore prior to leaching (Flowsheet IV) is exemplified by the reduction roasting of nickel-bearing laterite at Nicaro, Cuba, and the reduction roasting of manganese ores to convert MnO_2 to acid-soluble MnO. Thermal pretreatment of concentrate (Flowsheet V) is practiced in the roasting of zinc sulphide concentrate prior to leaching, and in the reduction roasting of cassiterite concentrate to produce the soluble SnO, or tin metal.

The information in Table I indicates that hydrometallurgy is currently applied to the recovery of at least sixteen metals. The production of six of these metals (Al, Be, Mg, W, U, Ra) is entirely by hydrometallurgy. In the production of the remaining nine, hydrometallurgy occupies an important (and growing) part in seven (Co, Cu, Au, Mn, Ni, V, Zn).

What Determines the Flowsheet?

The factors determining the method of treatment for any metal-recovery problem are complex and involve economic as well as technical considerations. There are, nevertheless, certain guiding principles which are apparent by inspection of Table I, and by comparison of hydrometallurgical and pyrometallurgical processes when these compete directly. (*Next page.*)

THERMAL PRETREATMENT

Thermal pretreatment may be required when the valuable minerals resist dissolution in inexpensive leach solutions. The methods of thermal pretreatment are as varied as the kinds of ore treated. Some of the most important types are:

1) Oxidizing-roast of sulphide minerals (zinc).

2) Reducing-roast used to convert higher oxides to lower oxides and, in one case, to reduce to the metallic form (manganese, tin, nickel).

3) Sintering or fusion of acidic minerals with sodium salts to form water-soluble sodium salts with the valuable metal in an acid-radical (aluminum, beryllium, tungsten, vanadium, uranium).

Inspection of Table I shows clearly, in three cases, that thermal pretreatment is in competition with direct leaching carried out by elevated temperature and pressure—so called pressure-digestion. The Bayer process for treating bauxite by pressure digestion is preferred over the "sinter process" which employs thermal pretreatment. It was recently reported that the U.S. Vanadium Corp. is using pressure-digestion for treatment of scheelite concentrate, in preference to the usual thermal method. Finally, there is current intrest in using pressure digestion, possibly in the presence of O_2 enriched air or pure oxygen, for the ammonia leaching of refractory sulphide and arsenide minerals of cobalt, copper, and nickel.

Pressure digestion increases the rate of mineral dissolution for two reasons: The rate of solution increases as the temperature increases; and, in the cases where oxygen is necessary for the dissolution reaction (as is the case of solution of sulphide minerals and gold), the concentration of the oxygen can be increased over its normal value by the elevated pressure and by use of pure oxygen rather than air. By this method it is possible to leach otherwise refractory minerals and to avoid the relatively expensive step of thermal pretreatment.

CONCENTRATION

Table I indicates that concentration is used prior to leaching except for some ores of aluminum, gold, copper, nickel, manganese, uranium and vanadium. With each of these exceptions, the ore is either high grade as mined (bauxite, MnO_2), or resists known methods of physical concentration completely or in part. Within the second group, Nicaro ore is finely disseminated, possibly a solid-solution of nickel oxide in silicates; the carnotite ores are easily slimed and have not been concentrated satisfactorily. The concentration of oxidized copper ores is usually unsatisfactory. Where flotation is possible, reagents are usually complex and consumption high. No major production of copper involving concentration from oxide ores in the Western Hemisphere is reported, although Panda and Nchanga in Africa have used flotation on ores high in oxide copper. The weight of practice appears to favor the direct leaching of low-grade ores only if physical methods fail, completely or in part, to yield satisfactory concentrate grade or recovery.

HYDROMETALLURGY VS. PYROMETALLURGY

Using leaching - precipitation rather than smelting methods for primary metal extraction is exemplified for the production of aluminum, magnesium, tungsten, vanadium, beryllium, nickel and manganese metals. Two factors determine this practice.

1. Direct leaching of low-grade ore is usually more economical than direct smelting. This is suggested by the Nicaro practice with nickel, by the present efforts to develop leaching methods for low-grade manganese ores, and by the contention that, on lead ores which resist concentration, leaching and electrolysis can compete favorably with smelting.

2. For the production of the more active metals, leaching is favored over smelting because it's hard to obtain pure metals by thermal methods. With such metals, refining by selective oxidation of impurities fails because the metal is more readily oxidized than the impurities. Leaching, however, effects a major separation from impurities, and is followed either by electrolytic precipitation of the metal or chemical precipitation of pure metallic compounds, which are then thermally reduced to metal. Magnesium is an interesting borderline case in this category in that Flowsheet I involving only hydrometallurgy appears to survive competition in a buyer's market. Under the stimulus of increased demand, plants using the pyrometallurgical methods are now resuming production.

BORDERLINE CASES

The preceding generalizations indicate the mandatory application of hydrometallurgy where the concentration-smelting route cannot be followed, or for the recovery of the more active metals. There are, of course, borderline cases where competing processes now coexist.

In the case of zinc production, current statistics indicate that approximately 40% of primary zinc metal is produced electrolytically (Flowsheet V) and 60% by retorting. Both processes are technologically competitive. The electrolytic process requires availability of ore near cheap power. Smelting requires cheap fuel. The significant factor determining the production of electrolytic zinc is the demand for the characteristic high-purity product.

Treatment of copper ores presents a more complex picture. A large fraction of copper production is obtained from mixed sulphide-oxide ores. Where the proportion of oxidized copper is low, flotation-smelting is the preferred treatment (Utah Copper, Ajo). This is still true with slightly higher proportions of oxidized copper (Miami, Chino, Morenci), although in some cases leaching of all or part of the copper in ores of this type has been considered. With a major proportion of oxidized copper, practice is mixed. Chuquicamata has been able to mine selectively, treat oxide ore by acid leaching-electro-winning, and will now treat sulphides by flotation - smelting. Inspiration leaches an ore with about one-half its copper in the sulphide form. Nchanga, on the other hand, has treated ore with similar proportions of oxide and sulphide by flotation-smelting. The Panda plant at Katanga has leached an oxide concentrate.

Leaching of mixed copper ores has its advantages and disadvantages. Where percolation leaching is possible, the saving in grinding cost can be considerable over that required for flotation. Less water is generally required for leaching than for flotation, and a more unified operation results with the leaching-electrolysis flowsheet. On the other hand, because of this close integration the process is less flexible than concentration-smelting, and the tonnage treated is less readily varied. Direct leaching, in contrast to flotation-smelting, has the further disadvantage

of failing to recover precious metals when these are economically important.

Until recently the metallurgy of **nickel** has been based on smelting as the primary extractive step. The ever-growing demand for special steels and other nickel alloys has turned attention to low-grade nickel orebodies and complex concentrates. The Nicaro project adopted leaching by necessity as a result of the low-grade and refractory nature of the ore. However, there are indications that leaching is now receiving serious consideration even for the treatment of sulphide-nickel concentrates. The Chemical Construction Corp., in collaboration with Sheritt-Gordon Mines, and Professor Forward of the University of British Columbia, has developed a leaching process whereby a nickel-copper-cobalt concentrate may be separated into its constituent metals; commercial application of the process is being considered. The conventional pyrometallurgy of nickel-copper ores has always been beset by the difficulty of making a clean separation between copper and nickel. The Orford (tops and bottoms) process at International Nickel is apparently being replaced by differential flotation of nickel and copper sulphide from crystallized matte, but the indications are certainly strong that where new construction is required, the extraction and separation of copper and nickel by leaching may offer distinct advantages.

The trend toward leaching is even more evident in the case of cobalt. The treatment of the Blackbird, Idaho, cobalt ore by Howe-Sound Corp. will in all probability involve ammonia-leaching of the cobalt-copper concentrate. Rhokana Corporation's copper-cobalt-iron concentrate at Nkana, in Northern Rhodesia, has in the past been treated by a complicated procedure: the concentrate was smelted to matte and converted for recovery of most of the copper; the converter slag was then smelted in an arc-furnace to produce a low-grade cobalt alloy, which was shipped to England for further treatment; the recovery of cobalt by this treatment was low. Rhokana recently reported two alternative leaching flowsheets to replace the smelting procedure. In one, the concentrate is selectively roasted to form cobalt sulphate and then leached with water; in the other, the concentrate is smelted to matte and leached with hot sulphuric acid. In either case the recovery of cobalt would be by electrolysis, and is expected to be higher than with smelting.

These Developments are Boosting Leaching

ORES TREATED: It is noteworthy that many of the metals listed in Table I are of strategic importance. The excess of demand over supply in these cases is due in part to a lack of adequate reserves in this country, and in part to the failure of a simple dressing and smelting procedures to permit the utilization of low grade ores. **It is almost certain that with a sufficient price incentive and a textbook of inorganic chemistry, any metal can be recovered by hydrometallurgical methods from any ore.** This is not true with either beneficiation or pyrometallurgy. This characterization of hydrometallurgy does not contradict the fact that pyrometallurgical methods are often more economical. But it does mean that the methods of hydrometallurgy may be expected to suceeed where others fail, and that in such cases the problems are more likely to involve process costs, reagent costs and availability, rather than adequate metal recoveries and separations. If, as appears inevitable, metal recovery in the future will involve the treatment of lower grade and more refractory ores, then it is equally likely that the importance of hydrometallurgy will increase.

LEACHING METHODS: Mention has already been made of the growing interest in and the reasons for the use of pressure digestion in accelerating the rates of solution of ore minerals. Continued improvements in leaching equipment, such as agitators, thickeners, pumps and corrosion resistant materials; better understanding of the mechanics of agitation and mixing; increased knowledge of the physical chemistry and thermodynamics of leaching; and the development of pressure digestion processes all should aid in development.

PRECIPITATION METHODS: In this field, electrowinning has been perfected for metals through manganese in the activity series. Diaphragm cells have been successfully developed for a number of applications. In another direction, the use of reducing gases such as hydrogen and carbon monoxide under pressure for precipitation of metals from solution is frequently reported in the literature and is rumored to be on the verge of practical application. Ion exchange is under investigation for several metallurgical applications. While available resins are for the most part lacking in selectivity for the adsorption of the usually occurring metal-ion mixtures, the process has possibilities for non-selective concentration of dilute wash solutions. The development of more selective resins could be of value in purifying leach liquors.

THERMAL PRETREATMENT: A significant development in this field is the FluoSolids technique for gas-solid reactions. With particles coarser than 200-mesh which do not tend to sinter, this process is reported to have the advantages of close control of temperature and gas composition, and efficient heat utilization. Its application to roasting of zinc concentrate, low-grade copper-pyrite concentrate, and gold-bearing arsenopyrite, all preparatory to leaching, is reported.

The authors are indebted to many colleagues in the field of mining and metallurgy for unpublished information used in the preparation of this article.

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PRODUCTION FOR DEFENSE

A SURE WAY TO INCREASE PRODUCTION AND LOWER COSTS

Make Your Air System Efficient

COMPRESSED AIR is a "friendly" kind of power. Maybe that's why it is so commonly abused. It has great flexibility and versatility, can be used in light, simple machines, is relatively safe, helps cool and ventilate workings, and does not fail suddenly.

Its disadvantages are that in some machines it is noisy, creates fog, and as a source of power is relatively expensive.

BUT the possible cost savings through using alternative sources of power are trifling compared to the following costs: (1) of labor, (2) of lost production, and (3) of downtime of expensive installations. The kind of power that will save on these items is the most profitable power for mining, regardless of its own cost. Only where these items are relatively in balance does sound management justify a choice between alternative types of power based on their own costs.

AND, the great pity about the use of compressed air is that it is commonly grossly abused. **The cost of making an air system efficient is small compared to the costs that slipshod management absorbs through labor inefficiency, production losses, and downtime by tolerating inadequate compressor capacity, too-small lines, expensive leaks, and poorly maintained machines.**

HERE IS A CHECK LIST TO STEP UP PRODUCTION

If this won't help you, you're far better than average:

1. Inspect your air system for leaks, particularly fittings and hoses. Repair them. Air costs you about 5 cents per thousand, if efficiently provided.

2. Check typical air-driven machines in use for performance against similar machines known to be in good condition. If those in use are not efficient, it's really costing you money and your maintenance routine needs going over. Preventive maintenance is best.

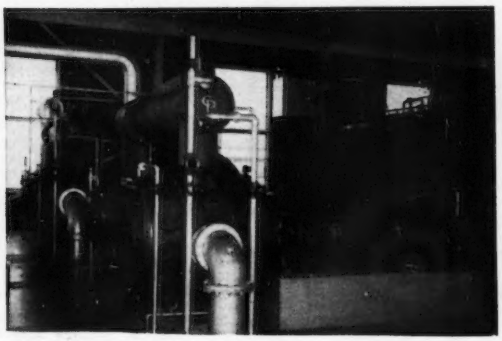
3. Make a systematic, around-the-clock check of the air pressures at the machines while working. Analyze the sources of your bad spots. Are they traceable to (a) inadequate lines (i.e., friction losses), (b) too-long lines, (c) lack of compressor capacity for peak loads, or (d) lack of total compressor capacity in 24 hours?

4. If (a), the lines must be improved. Do so, but first analyze the relative merits of a loop (preferred) system, parallel lines at "tight" segments, and replacement by larger lines. The main ultimate cost is labor, and oversize lines are likely to pay out many times over in the long run.

5. If (b), you may need a booster station or a separate compressor plant closer to the end of the long line. If this suggests an underground plant, weigh the alternatives carefully against putting in a larger line, considering: (1) Is there a supply of cool, clean air and water? (2) Is the type of capacity you would install mechanically efficient? (3) Are you prepared to provide competent operating personnel at that point?

6. If (c), before resorting to enlarged compressor capacity, study what added receivers will do for you if installed at points near your working places.[1] Manufactured receivers may solve short-peak problems. Check the cost of sealing old drifts to make large receivers against the following points: (1) savings from running present compressor capacity around the clock at relatively constant discharge pressures; (2) savings from eliminating losses of air pressure while compressor plant or main lines are out of service. If analysis won't justify such receivers, you need more compressor capacity.

[1] With adequate receiver capacity you may also be able to benefit from automatic unloading of compressor during short-period peak power demands.



MOST EFFICIENT, and thus most economical where the property is large and long-lived enough to justify the investment, these large compressors have the advantage of maximum mechanical efficiency. View is in Magma's new plant at the San Manuel property, Ariz.

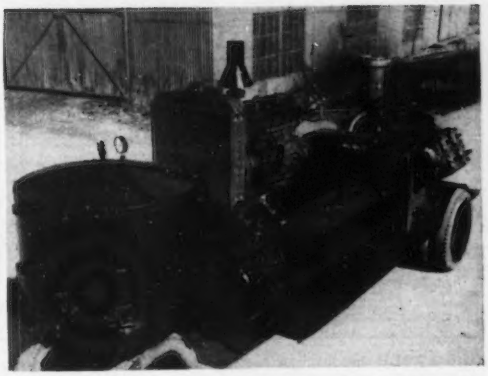
PORTABLE DIESEL-DRIVEN compressor for open-pit work has oil-cooled, two-stage rotary compressor capable of delivering 600 cfm at 100 psi, sufficient to drive two large wagon drills. Can be used underground also by taking precautions to scrub diesel exhaust.

7. If (d), you need additional compressor capacity. Whatever the cost, if you are running machines to any significant extent below their normal 90-lb. working pressure, the investment will improve productivity and save money out of all proportion to its cost and operating expense. According to the *"Compressed Air Handbook,"*[2] an increase in working pressure from 70 to 90 psi will increase the drilling efficiency of a typical rock drill by 41%. This is likely to improve the productivity of labor engaged in drilling about 14% (assuming ⅓ of total working time is spent in drilling).

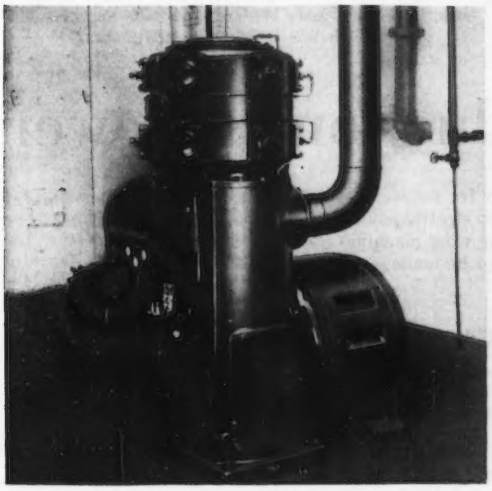
8. Think of the future in making changes. What seem to be oversize installations at the time usually are well worthwhile before you've done with them. In the typical situation, the property has outgrown its air system, but goes on with a costly "make-do" attitude.

9. When your system is modernized, give it proper lubrication and regular inspection.

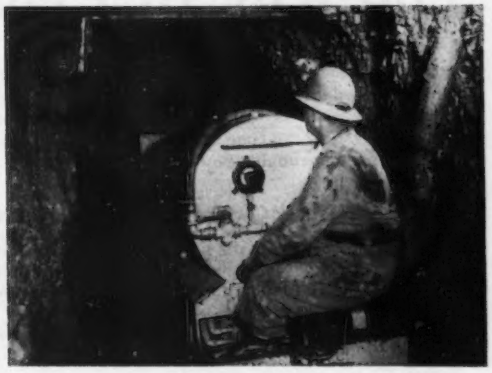
[2] Compressed Air and Gas Institute, New York, N. Y.



SHOP-MADE WHEEL-MOUNTED diesel-driven air-cooled compressor built for underground use in Tri-State district. Oxygen from pressure vessel is injected into diesel intake to prevent fumes and toxic discharges.



LOW INSTALLATION COST is the special advantage of this streamlined L-type compressor, which has drive motor, 2 compressor stages and intercooler, all balanced on a single frame. This "packaged" design requires small floor space and is simple to install. Available in 125 to 350 hp.



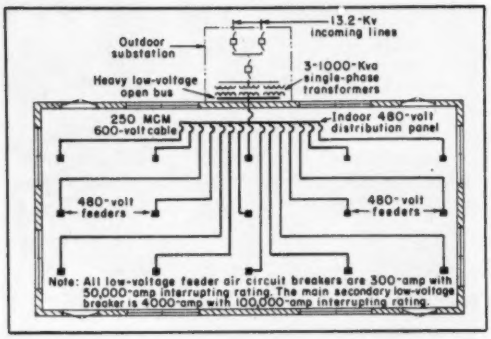
AIR-DRIVEN TRAMMER has proven to be inexpensive, convenient, and useful. Operators find them dependable and much less costly than hand tramming. They are readily broken down for portability and handling in shafts, are simple to maintain, and easy to operate.

MINE-CAR COMPRESSOR UNIT, for "spot" jobs where air connections are not available or for emergencies. This 130 cfm at 100 psi model is electrically driven, air-cooled, and only 27 in. high by 58 in. wide. Standard motors are 250 or 500-volt d.c., either permissible or open-type.

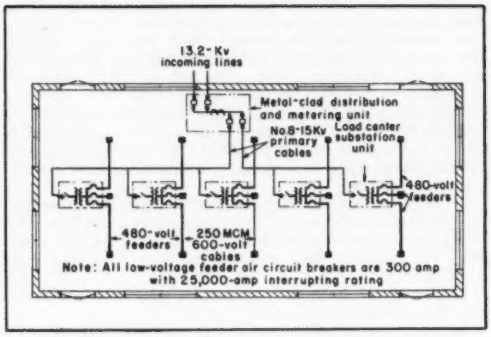
What Kind of Air Plant?

WHICH ARE MORE EFFICIENT, large, intermediate, or portable compressors? A single air plant, the same with boosters on longer lines, or dispersed compression?

Unfortunately there is no simple answer to this question. Distance from the plant to the air-driven machinery is always a handicap, because of friction losses, leaks, and the cost of air lines and their maintenance. Nevertheless, the larger machines are mechanically more efficient (in general, about 20%); cool, clean air and good water are important; and proper handling is the cheapest in the long run. If dispersed compression means, to any important extent, loss of compressor efficiency, bad air or water, or casual operating attention, it is likely to be a poor investment. Length of installed life is also important. For a long life the larger machines, despite their larger installation costs, are likely to give the best over-all results. *(Continued on p. 214)*


13.2-Kv incoming lines
Outdoor substation
Heavy low-voltage open bus
3-1000-Kva single-phase transformers
250 MCM 600-volt cable
Indoor 480-volt distribution panel
480-volt feeders
480-volt feeders
Note: All low-voltage feeder air circuit breakers are 300-amp with 50,000-amp interrupting rating. The main secondary low-voltage breaker is 4000-amp with 100,000-amp interrupting rating.

OLD-STYLE layout has one substation and long, expensive, energy-dissipating secondary conductors. Cable cost is nearly triple that of . . .


13.2-Kv incoming lines
Metal-clad distribution and metering unit
No.8-15Kv primary cables
Load center substation unit
480-volt feeders
480-volt feeders
250 MCM 600-volt cables
Note: All low-voltage feeder air circuit breakers are 300 amp with 25,000-amp interrupting rating

MODERN LAYOUT, which puts high voltage closer to work, is cheaper, more efficient, and costs approximately one-fifth less to purchase and install.

The Key to Production Is Power

What you pay today for one average workman will pay for the work of 2000 unequipped men, when applied through machines by electric power! The most expensive way to operate is to have men doing what machines can do—or wasting the time of your men and equipment by inadequate, inefficient or undependable power.

THE ABC OF POWER EFFICIENCY

A. Don't put power costs first. If you are wasting men's time by saving on power, you have the cart before the horse. The cheapest power is that which makes the most of your manpower and equipment.

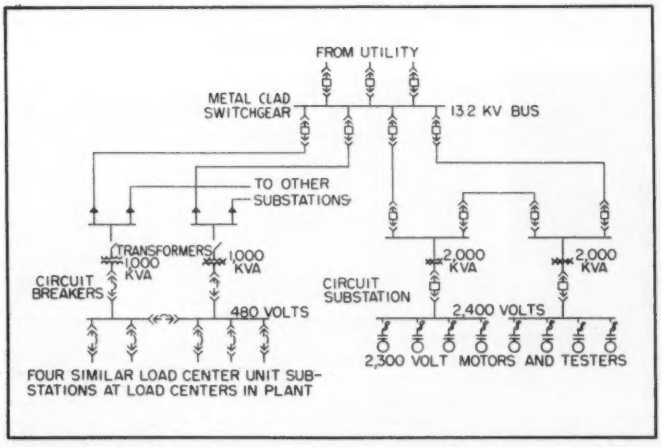
B. But an efficient and dependable power system will pay both ways. Mines are characteristically expanding plants. Most mines have inefficient power systems because their growth was not anticipated.

C. High voltage alternating current is most efficiently transmitted. Bring your primary current in at not less than 2200 volts (preferably above 4000 volts) and carry it as close to the working areas as is feasible, stepping down at scattered spots near the machines to the working voltages or converting to D.C. Keep your low-voltage and D.C. lines short. Mechanical efficiency drops as the square of the voltage drops below your motor ratings.

D. On machines, use A.C. wherever load is reasonably steady, such as on compressors, pumps, drills, lights, scrapers, continuous loaders, fans, conveyors, crushers, ball mills, tables, and flotation machines. Use synchronous motors wherever constant-speed loads are reasonably steady and load requirements are above 75 hp. at 350 rpm and above 650 hp. at 1800 rpm (they help power factor). In general, use high-voltage motors above 200 hp. and 440 to 480-volt motors below 200 hp. Do not underload motors—well-loaded motors are more efficient.

On haulage, and where changing torque characterizes the loads, such as on shovel dippers, use D.C., taking particular care to keep lines short. For long trolleys, it may be worth while to have several rectifiers feeding power to the trolley rather than a single conversion point. Usual D.C. voltage is 200-250—a reasonable compromise between power efficiency and safety.

For hoists, the preferred power is D.C. with a synchronous-motor-driven converter. When the primary power system cannot take the sudden drain of hoisting-load peaks, an induction-motor-driven



SYNCHRONOUS MOTORS, if used for milling or air compression at lower right, will save money and improve power factor. Portable equipment at lower left and 480-volt operating circuits afford flexibility and efficiency.

HANDY, HOOK-ON power factor meter helps in ferreting out weak spots in your A.C. power system.

converter with flywheel will keep load on primary circuits steady.

E. If your power supplier offers you a substantial discount for off-peak power, equip your pumping stations to do off-peak pumping. In some instances it may be suitable to do off-peak drilling, hoisting, or crushing.

F. In the average case where a mine uses D.C. (low average load), modern rectifiers are more efficient than rotary converters.

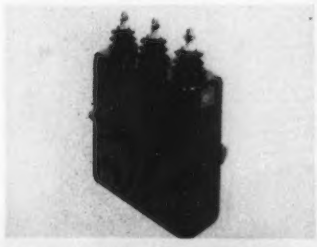
G. On your A.C. circuits, power factors under 0.85 are unsatisfactory and will pay to improve. If you can't correct with synchronous motors, use capacitors. They are available down to 25 kva size. Put capacitors as close to loads as possible—they do not correct "downstream conditions."

H. Be sure that your system is safe. It can be made so and you have no right to endanger people unnecessarily. Also, an unsafe system can cause an expensive fire.

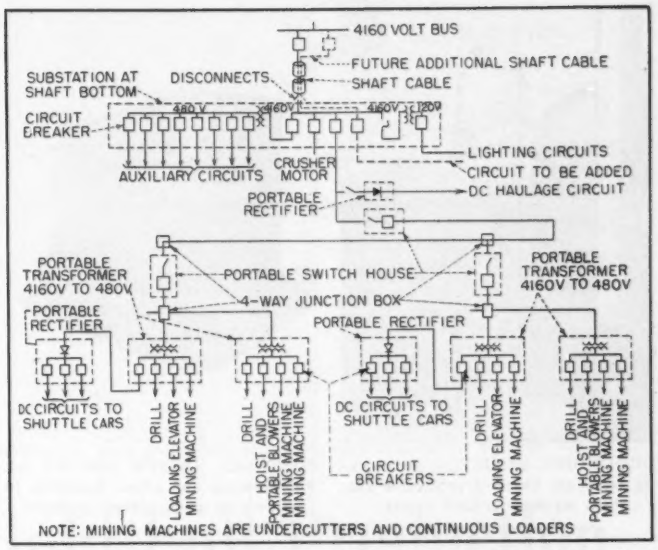
I. Have detection apparatus installed to check your system for leaks—they are both expensive and dangerous.

J. Electrical design is a job for a specialist. Don't hesitate to consult the manufacturers for advice, or get the services of a trained specialist.

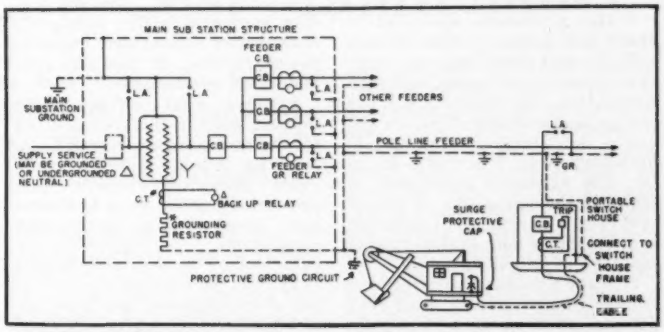
K. Preventive maintenance pays.



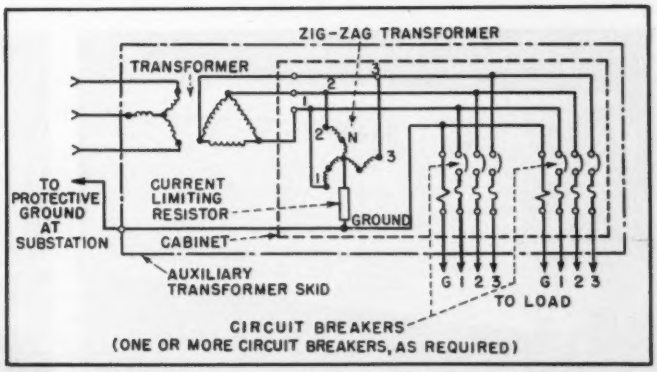
SMALL SIZE and ratings of capacitor units permit use individually at key spots or grouped for larger loads.



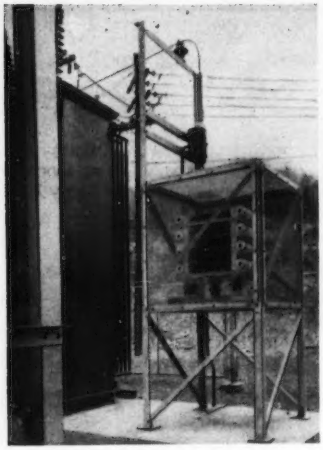
MODEL SYSTEM of a Southwestern potash mine has efficient voltages, short secondary circuits, and great flexibility.



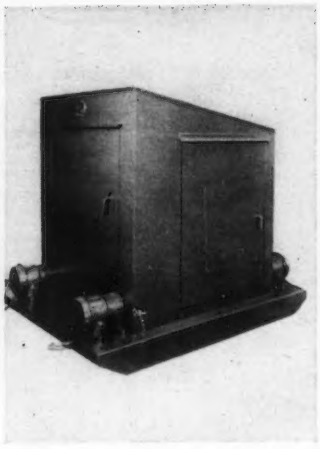
SAFETY COMES FIRST in this grounded-neutral protective system, with resistor to prevent dangerous shock, and relay to shut off power.



ALTERNATIVE grounding protection for delta-connected transformer, uses zig-zag transformer, resistor, and circuit breaker. Diagram shows "package" unit for portable substations.



GROUNDING RESISTOR and back-up relay are heart of protective system against ground faults.



PORTABLE SWITCH HOUSES are weatherproof and afford flexibility to surface or underground systems.

Power Plant Check List

1. Get a trained specialist to check your power system—or consult the manufacturers—to study your power weaknesses and estimate where improvements will pay out in a reasonable time. In deciding, don't forget that during inflationary times it is costly to delay. The expensive investment of today is the cheap one of tomorrow. Don't assume that inflation is at an end as long as Government indulges in deficit spending.

2. Make a detailed study of your voltage changes during short peak periods (such as when your hoist is pulling its hardest) and of the performance of your machines. Slow motion doesn't pay. Correct slow motion by higher voltage (if low), better conductors, improved power factors, or adequate-sized motors (if overloaded).

3. Check your voltage drops. Correct leaks in the system. If excessive on primary circuits, put in higher primary voltages or adequate conductor capacity (and protection). Study ways to shorten your lines, such as by borehole connections. If on secondary circuits, extend your primary system to shorten your secondary circuits. See that conductors are adequate, or consider stepping up your secondary voltages to 440-480. If the voltages at machines are less than 95% of their ratings, you aren't getting satisfactory performance.

4. Check your trolley voltage drop. If excessive, consider multiple rectification or larger wires. Also, check the resistance in your return. Maybe what you need is some copper wire bonded to the track (you might be surprised).

5. Study your air system. High-voltage A.C. is cheaper to transmit than air over long distances. If you can have 2 or more plants of sufficient size to be efficient and to have proper care, and if there is a supply of cool, clean air and water, it may pay to get your compressor plants closer to the work.

6. Check your power factors over the system. Any below 0.85 should be corrected by synchronous motors, by capacitors, or by proper loads on motors.

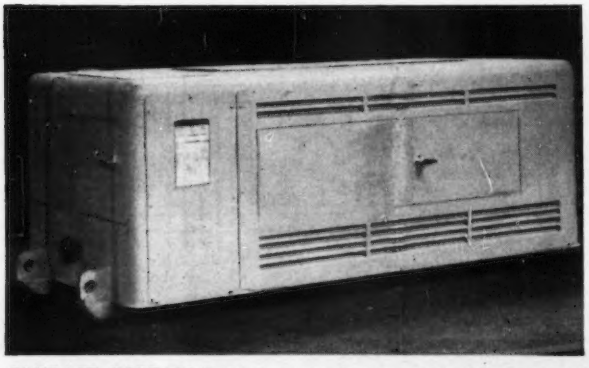
7. Study your motor loads. Underloaded motors are inefficient.

8. Study your operation with a view to using off-peak power or to ironing out peak loads. Maybe you need a different hoist motor, an automatic control to unload compressors or stop pumps and fans during short power peaks, or a dispatching system to flatten out your power demand. Maybe some work can be done on other shifts. Maybe you need an auxiliary generating plant for peak periods.

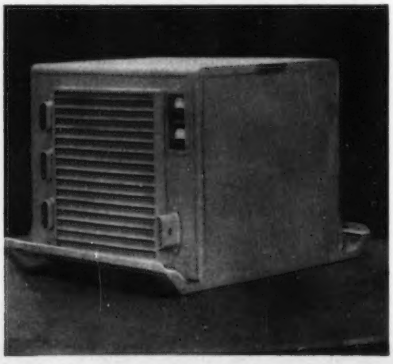
9. Make your system safe against personal hazards, fire, and excessive losses from broken circuits due to faults or overloads.

10. Check your downtime due to electrical failures. Maybe you need preventive maintenance, regular inspection, better maintenance, or more parts and spares.

Grateful acknowledgment is made for assistance from S. F. French, the General Electric Co., A. C. Stevenson, and Westinghouse Electric Corp.

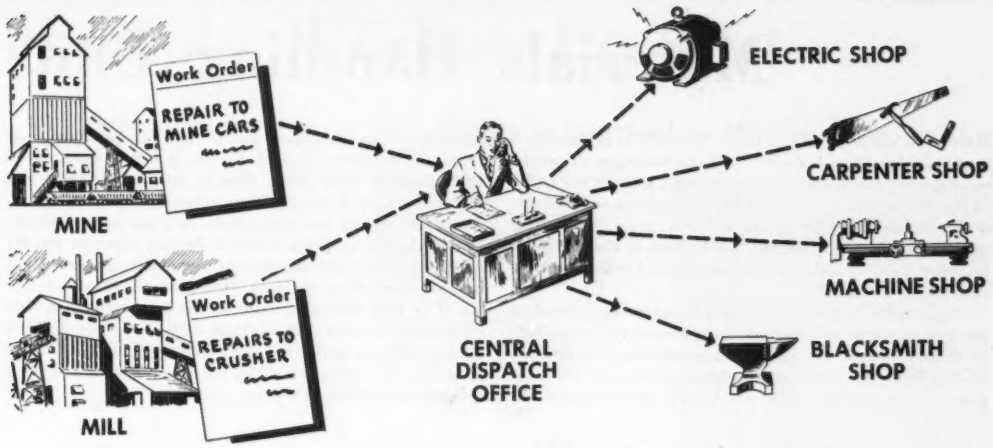


COMPACT, PORTABLE 300 kva transformer unit is drip-proof and provides ground fault, short-circuit and overload protection.



PORTABLE RECTIFIER, for keeping D.C. circuits short, contains safety devices.

PRODUCTION FOR DEFENSE — In The Shop



FOR BETTER CONTROL, all maintenance work orders are routed through the central dispatch office

How To Hold Full Production Through Low-Cost Maintenance

Remember that maintenance may take from 15% to 25% of your mine's operating dollar. That's why Hollinger, as described by Mr. Turner, makes sure its maintenance cost pays off in minimizing shutdowns.

E. T. TURNER
Plant Engineer

Hollinger Consolidated Gold Mines, Ltd.,

Timmins, Ont.

AFTER TWO YEARS' OPERATION on a planned program of control of maintenance costs we are beginning to realize some of the savings from cost control. From January 1, 1950, to January 1, 1951, we have been able to reduce our shop workforce from a total of 299 down to 268, a saving of 31 men. The machine shop, previously on a three-shift operation, now covers the work on two shifts and we are working toward a single day shift. The one-time large backlog of unfinished, overdue work orders in the various shops has disappeared.

Early in 1948, the Plant Engineering and Service Division started a preliminary skirmish with the facts to determine exactly where we stood. Drawing from past experience with cost control systems in other plants and culling many ideas from articles in *Factory Management & Maintenance* magazine, a three-step program of control was proposed.

Shop foremen who had never been required to watch maintenance costs too closely found the new concepts difficult to accept at first. There had to be discussion periods during which new ways of doing things become accepted as being the right and practical way of doing them. We realized also that any changes or introduction of new methods in handling maintenance work orders by the Service Division to be successful would have to be understood and accepted wholeheartedly by all the operating departments placing such work in the shops.

1. Establish Preventative Maintenance and Service Factors

AS A FIRST CONTROL STEP it was necessary to analyze and establish the optimum amount of maintenance service, consistent with sound economics, that was to be rendered the Mine, Mill and surface operations to keep plant shut-downs to a minimum.

Management clearly fixed responsibility by ruling that producing departments would be made responsible for all costs other than those coming under the heading of "general." Consequently, the Mine and Mill Departments must be able to justify all work requests they make on the Service Division. It is the operating department that actually sets the service factors or amount of maintenance work required. It is the Service Division's responsibility to provide those services.

Preventative maintenance plays a large part in this question of setting up optimum service factors and so far we have only started the long task of determining what are ade-

(Continued on p. 164)

Materials Handling Units

METAL AND NON-METALLIC MINING is essentially a materials handling industry. If huge tonnages of waste, development muck, overburden, tailings, and fill are added to the 280 to 300 million tons of metallic and non-metallic ores produced annually in the U. S. A. alone, the mining industry ranks easily among the highest in the materials handling field. (In this article materials handling will be referred to as "MH".)

Mines, mills, and smelters are striving steadily to adopt the best methods and equipment to handle the great bulk of their products such as ore, concentrates, and metals. In addition, there is an open field of opportunity to boost productivity and cut costs by taking advantage of the latest handling techniques and devices for handling large collateral tonnages of steel, timber, grinding balls, liners and countless other items (See p. 153, listing important items that have to be handled in mines, mills and smelters.)

In fact, mining can well afford to keep its eye on the manufacturing industry which is far advanced in the art of MH. But even the manufacturing industry concedes that it could slice off $2 billion a year from its $8 billion MH bill if it took full advantage of the best techniques and equipment available today. Thus it's safe to say that the mining industry could save more than 25% in the handling of materials to keep the mines, mills, and smelters running by adopting modern MH programs.

THE FOLLOWING POINTS which will prove helpful in attacking MH problems in the mining industry were brought out in the recent Materials Handling Conference in Chicago and other authoritative reports on the subject:

1. When is a MH program justifiable? "The work and expense of planning a MH program and applying the program effectively can only be justified by the reduction of handling expenditures," according to J. O. Abney, Supervisor of Methods and Standards Department of the Chevrolet Div., General Motors Corp.—in other words, only when the program will pay its way.

2. How do you know that the program will pay? Your accounting system must be comprehensive and specific enough to segregate true handling charges from other operating costs. For instance, a skilled mechanic who spends much of his time carrying machine parts around is not strictly on the mechanical payroll. Some of his time should be charged to MH. Similarly, the skilled flotation operator who spends part of his time toting lime sacks is also partially a MH charge. Once you are able to evaluate these factors properly you will be in a position to determine whether a MH program will pay or not.

Time studies are also indispensable in determining the value of contemplated MH programs.

The following excerpts from an article on cost cutting (E&MJ Vol. 150, pp. 80-81) are evidence that U. S. Smelting Co. evaluates its MH charges carefully:

"It is estimated that the labor savings on the timber handling alone will pay for the $15,000 fork-lift-straddle combination in about two years,"—and referring to a tractor-type scoop-loader with bulldozer blade and crane-hook attachments used in the smelter yard of the same operations . . .

"It is estimated that labor saving will pay for this equipment, which cost about $25,000, in about three years."

3. What advantages does a good MH program offer?

(a) Greater productivity.

Victor Radio reports that its MH program in the receiving department increased volumes of items handled by 270% with a decrease of 8% in the labor force.

Another company says that "the fork-lift truck by comparison with the two-wheeled hand-truck increased productivity by 1500%."

Frigidaire Division of General Motors Co. reduced MH personnel by 62% through use of a monorail system. (A mine in the Iron Country employs a monorail to handle timber.

A lead smelter estimated that productivity of workers handling 100-lb. lead pigs was multiplied 10-fold by substituting fork-lift trucks for hand trucks.

(b) Fewer accidents.

National Safety Council says that "hernia methods of sweat and brawn cause 25% of injuries requiring compensation."

In one smelter, a fatality occurred which might have been prevented if a mechanical elevating conveyor had been installed. A conveyor was installed.

(c) Saves space. Space is costly if it has to be roofed and walled in. The use of tiering (discussed later) made possible by modern MH units permits vertical stacking of timber and other items.

(d) Improves labor relations.

MH equipment appeals to the pride of the workman. It takes him out of the "bull-gang" class and puts him into the operating group.

(e) Less breakage and lower shipping costs.

4. What important new factors should be considered in planning a MH program?

(a) If the MH equipment is expensive, keep it busy. This is a fundamental rule in all mining operations and applies equally well to MH equipment. One way of keeping the units busy is to take advantage of the many adaptor gadgets that can be attached to such units as fork lift trucks, to multiply their utility (See page 153).

(b) Tiering saves space. The grunt - and - groan, hand - handling system necessarily limits stacking to the eye-level horizon, but the use of tiering or stacking devices and the fork-lift truck converts square feet of storage space under common roof to cubic feet of storage space. Note how the zinc slabs in the accompanying photograph (Josephtown smelter) are tiered, also how DuPont stacks its materials.

(c) The bigger the load, the more economical. Here again we have a well-recognized principle, and that is why mining companies like International Nickel Co. have gone to increasingly larger tonnage mine cars to cut haulage costs. The same applies to MH equipment. But to increase the load carried, strapping and palletizing must be considered.

Multiply Worker Productivity

(d) Palletizing, strapping, and preparing the bundle.

To take full advantage of the capacities of MH equipment, items to be carried must be strapped, or stacked properly on portable platforms called pallets. Note the strapping of mine posts handled by the fork-lift truck with side-grip attachments on page 155. The pallets for zinc slabs used at Josephtown (at right) are ingenious. These are called non-returnable or "one-way" pallets. St. Joe Lead Co. devised these zinc pallets with zinc feet that can be thrown into the melting furnace by the customer along with the rest of the shipment.

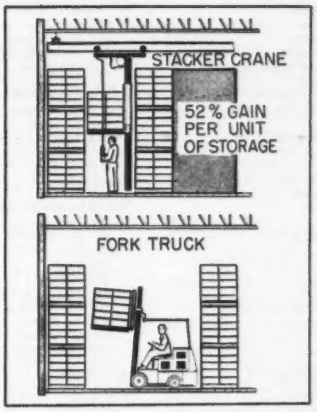
(e) Plant layout. A superintendent of a large open-pit copper mine recently commented, "If I had to do it over again, I would re-arrange the whole layout of the mine plant buildings." He was referring to the needless awkward handling of supplies and parts between warehouse, machine shop, truck repair shop, tire shop, etc., due to a haphazard arrangement of these buildings. He was finding out the "hard way" what factory production experts have long recognized—that design of a plant should be based chiefly on a smooth flow of materials and products through that plant.

This means (1) that mine, mill, and smelter designers should acquaint themselves with the most efficient MH units available, and (2) that the plant should be designed to take full advantage of the handling capacities of these units. As an example, note the concrete ramp construction incorporated into the design of Golden Cycle's modern Carlton mill in the Cripple Creek district. These ramps were built to facilitate the movement of industrial trucks between levels of the plant.

See also Kennecott's new refinery where much of the floor and yard space is served by overhead cranes.

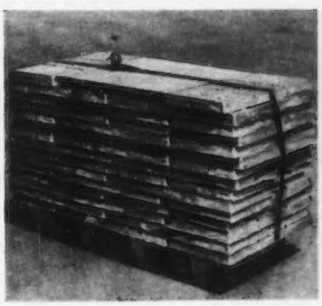
(f) Distance is a factor. A study of case histories indicates that distance over which materials are to be hauled is a critical factor in selecting equipment. For instance, industrial trucks are regarded as being most efficient for hauls up to 200 to 250 ft. Above this, tractors and trailers, or other units are more efficient.

Points to Consider in MH Planning



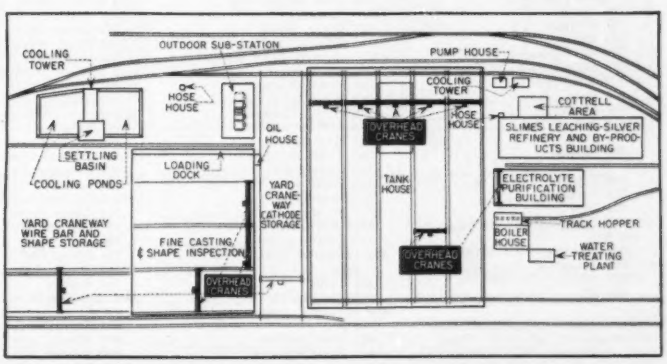
STACKING. Stacker crane and fork-lift truck compete to increase storage.

TIERING. Josephtown smelter stacks up pallets of slab zinc for storage.



NON-RETURNABLE PALLETS with zinc feet are used at Josephtown smelter.

GOOD PLANT DESIGN. Ramp for floor-to-floor trucks travel at Carlton mill.



GOOD PLANT DESIGN. Note how many square feet of floor space at Kennecott's new refinery at Garfield, Utah, are served by overhead cranes.

Turn the page for a classification of MH equipment →

How Experts Classify MH Equipment[1]

Mobile or Fixed Group

1. Cranes

.100 Overhead bridge, traveling
- .101 Power cab drive
- .102 Manual, chain drive
- .103 Push type
- .104 Weigh larry
- .105 Traveling platform

.200 Overhead bridge, non-traveling

.300 Gantry traveling
- .301 Portal
- .302 Semi-portal
- .303 Portable
- .304 Folding jib

.400 Gantry, traveling
- .401 Tower
- .402 Whirler

.500 Jib
- .501 Column rotary
- .502 Wall bracket
- .503 Pillar jib
- .504 Portable
- .505 Bracing types
- .506 Walking jib
- .507 Wall traveling
- .508 Folding jib

.600 Pillar
- .601 Straight boom
- .602 Curved boom

.700 Locomotive
- .701 Flatcar mount
- .702 Crawler mount
- .703 Truck mount
- .704 Floating
- .705 Pile driving
- .706 Wharf
- .708 Drag line
- .709 Magnet
- .710 Bucket types

.800 Derrick
- .801 Sulky
- .802 Stiff leg
- .803 Guyed type
- .804 Pole type (Gin)
- .805 Tower
- .806 Portable
- .807 Breast
- .808 "A" type

.900 Special
- .901 Tower crane
- .902 Floating crane
- .903 Wharf-gantry
- .904 Gantry-loco.
- .905 Transfer
- .906 Cantilever

.1000 Cableway suspensions
- .1001 Endless cable
- .1002 Single cable
- .1003 Telpher

.1100 Cableway tramway
- .1101 Overhead
- .1102 Surface

2. Conveyors

.100 Roller gravity
- .101 Spiral
- .102 Portable
- .103 Roller plain
- .104 "V" trough
- .105 Double deck

.200 Roller, live
- .201 Gear
- .202 Chain
- .203 Belt
- .204 Push bar
- .205 Magnet

.300 Wheel
- .301 Wheel
- .302 Portable
- .303 Disk
- .304 Cable drive

.400 Belt
- .401 Portable
- .402 Troughed
- .403 Piler
- .404 Flat
- .405 Feeders
- .406 Metal
- .407 Tower and track

.500 Drag
- .501 Pusher bar
- .502 Rotary
- .503 Screw
- .504 Flight
- .505 Enmasse
- .506 Floor chain buggy
- .507 Chain
- .508 Drag scraper
- .509 Chain dig loader

.600 Apron
- .601 Wooden slat
- .602 Steel slat
- .603 Carrier chain
- .604 Steel pan
- .605 Feeder

.700 Bucket

Mobile Group

3. Tractor & Trailers

.100 Tractor, road
- .101 Crawler
- .102 Road tractor
- .103 Half tracks
- .104 Trencher
- .105 Excavator
- .106 Grader
- .107 Shovel
- .108 Drag line
- .109 Roller
- .110 Crusher
- .111 Sweeper
- .112 Bucket

.200 Trailer, road
- .201 Semi-trailer
- .202 4-Wheel trailer
- .203 Low platform
- .204 Pole-type bolster
- .205 Track laying
- .206 Mobile loading platform
- .207 Pump
- .208 Grader

.300 Tractor, industrial
- .301 3-Wheel
- .302 4-Wheel
- .303 Trailer train
- .304 Pusher method

.400 Trailer, industrial
- .401 Caster steer
- .402 5th wheel steer
- .403 4-Wheel steer
- .404 Side dump
- .405 Bolster
- .406 Stevedore
- .407 Tool wagon

4. Trucks

.100 Road, motor transport
- .101 Crawler
- .102 Van
- .103 Commercial
- .104 Dump body
- .105 Elev. ladder tower
- .106 Spreader
- .107 Crane mount
- .108 Tank

.200 Industrial, hand, manual operation
- .201 Platform push
- .202 Hand lift for skids
- .203 Barrel (2-wheel)
- .204 Stevedore (2-wheel)
- .205 Box (low frame)
- .206 Pallet lift (pull)
- .207 Scale truck
- .208 Dolly
- .209 Gear type
- .210 Superstructures
- .211 Reel truck
- .212 Carboy truck

.300 Industrial hand, power drive
- .301 Pallet
- .302 Platform

.400 Industrial power, non-lift type
- .401 Low platform
- .402 High platform

.500 Industrial power, lift type
- .501 Low lift platform
- .502 High lift platform
- .503 Telescopic platform
- .504 Non-tele. fork
- .505 Telescopic fork
- .506 Ram-telescopic
- .507 Platform crane
- .508 Manual steer lift

.600 Power road or industrial special types
- .601 Straddle
- .602 Rigid boom
- .603 Swinging boom
- .604 Dumpster

5. R.R. Equipment

.100 Engine types
- .101 Electric
- .102 Steam
- .103 Diesel
- .104 Fireless
- .105 Trolley
- .106 Switch

.200 Cars standard gage
- .201 Box
- .202 Gondola
- .203 Flat
- .204 Tank
- .205 Hopper
- .206 Pot
- .207 Car dumper

.300 Cars, narrow gage
- .301 Side dump (auto.)
- .302 Side dump (manual)
- .303 Air dump

.400 Trackage
- .401 Rails
- .402 Ties
- .403 Gages
- .404 Frogs
- .406 Turntables

6. Tiering Machines

.100 Fixed frame portable
- .101 2-Post manual
- .102 4-Post manual

.103 Revolving base
- .104 2-4 Post power

.200 Telescopic frame portable
- .201 2-Post manual
- .202 4-Post manual
- .203 2-4 Post power

Fixed Group

7. Lifts and Hoists

.100 Elevator, freight
- .101 Electric
- .102 Hand power
- .103 Hydraulic
- .104 Pneumatic

.200 Elevator, passenger
- .201 Electric
- .202 Hydraulic
- .203 Hand power
- .204 Pneumatic

.300 Elevator dumb-waiter
- .301 Electric
- .302 Hand power

.400 Elevator, short rise, sidewalk or floor
- .401 Electric
- .402 Hydraulic
- .403 Hand power
- .404 Pneumatic

.500 Electric stairway
- .501 Passenger
- .502 Freight

.600 Hoists reciprocative
- .601 Skip hoist
- .602 Automatic
- .603 Semi-automatic
- .603 Portable elevator
- .605 Lowerer

.700 Lifts, continuous
- .701 Chain mount
- .702 Belt mount
- .703 Fixed tray
- .704 Swing tray
- .705 Single chain
- .706 Bucket

.800 Hoist units
- .801 Chain (portable)
- .802 Electric
- .803 Winch (portable)
- .804 Capstan
- .805 Windlass
- .806 Ratchet puller
- .807 Steam hoist
- .808 Pneumatic
- .809 Air trolley

8. Monorail System

.100 Carrier
- .101 Monorail carrier

.200 Trolley
- .201 Monorail trolley

.300 Chain
- .301 Chain buggy
- .302 Chain trolley
- .303 Enclosed chain
- .304 Pusher

.400 Telpher
- .401 Monorail telpher
- .402 Cable telpher
- .403 Automatic

9. Pneumatic System

.100 Tube rigid
- .101 Bulk conveyor
- .102 Unit conveyor
- .103 Portable
- .104 Bulk transport

.200 Pipe and hose rigid and flexible
- .201 Bulk loader
- .202 Bulk unloader

.300 Special
- .301 Vacuum systems
- .302 Blast systems
- .303 Portable compressor

Miscellaneous Group

10. Chutes

.100 Spiral
- .101 Curved chute
- .102 Closed center
- .103 Open center post
- .104 Open center

.200 Straight
- .201 Steel—wood
- .202 Canvas
- .203 Skid
- .204 Rail
- .205 Vibrating
- .206 Gates
- .207 Discharge (conveyor)

.300 Sluices and flumes
- .301 Wood
- .302 Metal
- .303 Pipe
- .304 Open

11. Industrial storage facilities

.100 Bins and boxes
- .101 Storage bins
- .102 Assembly bins
- .103 Port bins & boxes
- .104 Box frames

.200 Benches
- .201 Work

.300 Ladders and scaffolds
- .301 Straight rung
- .302 Step
- .303 Wheeler base

.400 Lockers and cabinets
- .401 Clothes
- .402 Tools
- .403 Supply

.500 Racks
- .501 Bar
- .502 Barrel
- .503 Tree
- .504 Portable

.600 Bunkers

.700 Shelving and drawers
- .701 Open
- .702 Closed
- .703 Roller
- .704 Unit

.800 Tables
- .801 Inspection
- .802 Work
- .803 Laydown
- .804 Machine tender
- .805 Die table
- .806 Lift table

.900 Tool containers
- .901 Portable—fixed
- .902 Portable—rotary
- .903 Tool rack
- .904 Die rack

.1000 Totepans
- .1001 Metal
- .1002 Wood
- .1003 Fiber

.1100 Pallets and trays

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[1] Classification developed by Westinghouse Electric Corp., and published in "Materials Handling Case Book" (McGraw-Hill Book Co.) edited by Lewis K. Urquhart and Carroll W. Boyce of Factory Management and Maintenance editorial staff.

. . . And What It Will Handle

Underground Mines

Ore, waste, sand and tailing fill; timbering—wedges, posts, caps, girts, nails, headboards, lagging, ladders; track equipment—ties, fish-plates, tie-plates, rail, rail spikes, frogs, switches, track bolts; explosives, tamping, and stemming; concrete, cement, sand and gravel, grouting; air and water pipe and fittings; air and water hose; ventilation pipe and tubing; drill steel, sectional drill steel, diamond drill rod, hoisting rope, slusher cable, electric cable; conveyor parts and belting; structural steel, steel plates, grizzley rails, roof bolts; skips, cages, shaft guides, sheave wheels; pumps, compressors, fans, blowers, hoists, jumbos, rock drills, locomotive parts, shaker conveyor parts, mine car parts; transformers, switches, rectifiers, batteries and battery chargers, control equipment; lubricants.

Open-Pit Mines

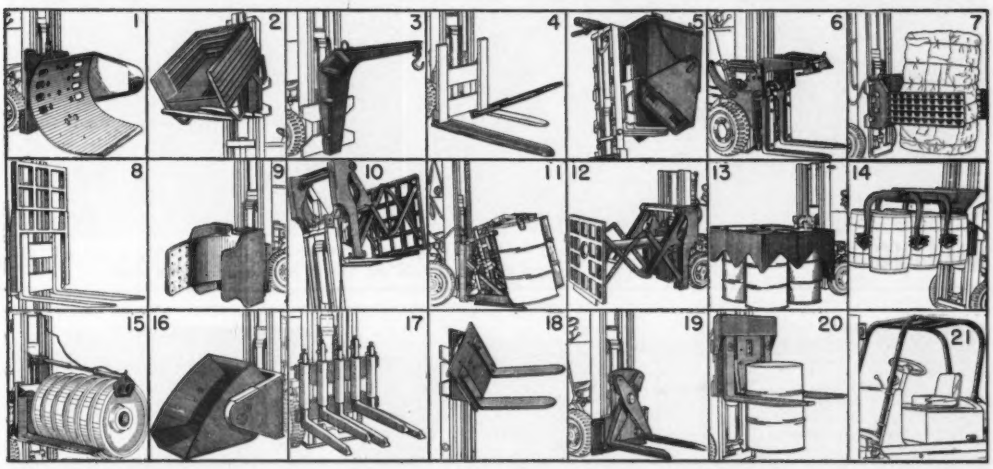
Ore, waste; power distribution units and cable; tracks, ties, panels, bolts, switches and switch parts, fish plates, tie plates, trolley poles and trolley wire; churn drill parts, cables, and bits; shovel parts, tractor treads, dipper sticks, dippers; dragline parts, cable, buckets; conveyor belting; explosives and stemming; trucks, truck parts and tires; lubricants, gasoline, and diesel fuel.

Mills

Ore, concentrates, tailings; reagents—lime, copper sulphate, cyanide, etc.; balls, rods, mill liners; repair and maintenance of ball mills, rod mills, crushers, classifiers, rolls, flotation machines, jigs, tables, pumps, thickeners, filters, spirals, elevators, and conveyor belts, screens, and grizzlies.

Smelters and Electrometallurgical Plants

Ores, concentrates, fluxes, slag, scrap, dross, matte, speiss, precipitates, cement copper, ingots, slabs, bars, pigs, anodes, cathodes, starting sheets; coal, fuel oil; refractories and retort linings; pipe, sheet metal, structural steel, masonry and building materials; molten metals and skulls; slurries, acids, dust, fume; leach solutions; and repair and maintenance of roasters, calcining furnaces, reverberatory furnaces, converters, casting wheels, leaching and purification equipment, filters, electrolytic cells, vacuum furnaces and electrothermic units.



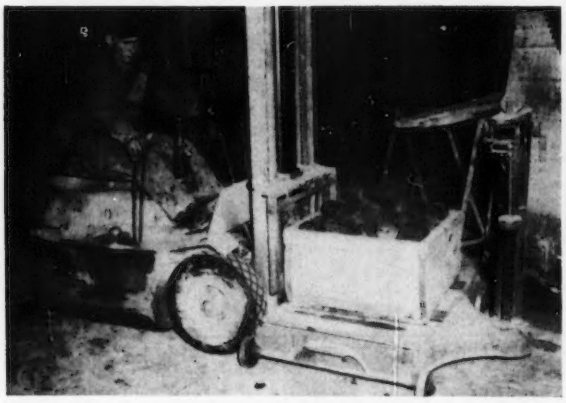
Attachments Make a Multi-Purpose Unit of the Lift Truck

1. Revolving roll handler.
2. End dump hopper.
3. Goose-neck boom
4. Removable fork extensions.
5. Bottom-dump hopper.
6. Clamp fork for tin plate.
7. Clamp for bales, boxes, crates, etc.
8. Back rest for high loads.
9. Hydraulic clamp.
10. Hydraulic pallet pusher.
11. Hydraulic double-drum handler.
12. Hydraulic pusher.
13. Multiple drum carrier.
14. Multiple keg handler.
15. Car-wheel handler.
16. Shovel scoop.
17. Multiple fork attachment.
18. Revolving fork unit.
19. Self adjusting fork.
20. Load hugger.
21. Safety canopy for operator.

(Courtesy Yale & Towne Co.)

PRODUCTION FOR DEFENSE—Multiply Productivity of Your Mine, Mill, and

MINING CRANE TRUCK (left) lifts and transports machine parts. Overhead crawler hoist (center) on swinging boom saves shop labor. Gasoline-powered dump wheel-barrow (right) is ideal for construction work at mines.



MILLING LAKE SHORE MINES in Ontario was one of the earliest to use the lift truck for materials handling in the mill. Unit (at left) is weighing in a charge of grinding balls and one at right transports mill liners.

SMELTING INGOTS (left) are discharged into palletized containers for transports by lift truck. Lift truck at Josephtown picks up load of palletized zinc slabs. Note that feet of pallets are made of special zinc castings.

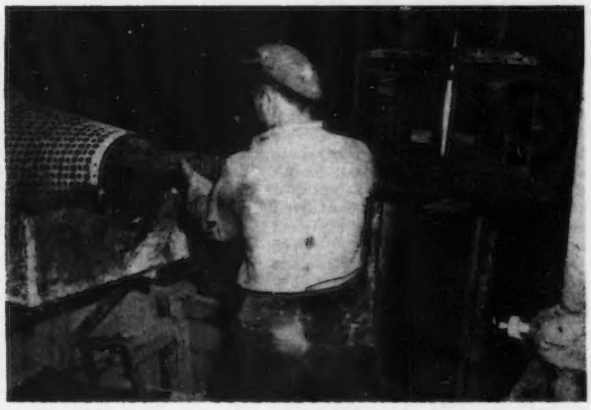
Smelter Workers With Modern Materials Handling Equipment

STRADDLE TRUCK at U.S. and Lark mines handles a 4-ton bundle of timber in yard.

FORK-LIFT truck at Hecla property transports kegs of spikes to mine shaft.

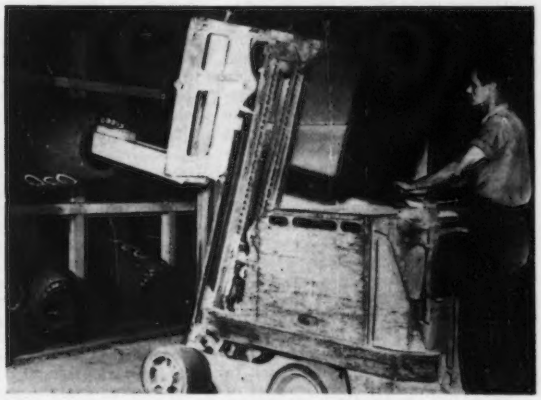
CLAMP ATTACHMENT at Hecla loads mine cage with bundle of posts.

SAME LIFT TRUCK picks up a load of rods for the grinding plant.



OPERATOR slides rods into mill after hoist on lift truck raises them to level of discharge opening. Same truck is used to handle filter sands and other materials.

SCOOP LIFT-TRUCK unloads ore from floor of box car and transfers it to smelter bins.



RAM ATTACHMENT enables operator of lift truck to remove retorts from stock bins and transport them for installation in furnace.

WASHINGTON IMPACT

Piecemeal Price Adjustments—Trend Toward International Allocation—Preferred Status for Mining—Subsidies Still Contemplated

The Office of Price Stabilization is planning to grant relief to domestic copper smelters handling Chilean ore and concentrates.

It's not certain yet what form the relief will take. OPS could put out an amendment to the general ceiling price regulation—the order that froze the price of copper at 24.5 cents a pound, and cure the two-price nonsense that now prevails. But probably the agency will grant special relief for the particular predicament of the custom smelting industry.

The pinch on custom smelters began when the State Department signed an agreement with Chile that fixed the price of that country's copper at 27.5 cents a pound, thus in effect creating a new world price, ex USA.

When OPA announced its decision to end price controls on manganese ore, it made one thing clear—it doesn't expect the price to go up much, if any. It holds the same view about chrome, on which it may also end price controls.

OPS decided to end manganese ore price control on the grounds that 95% of it is purchased abroad anyway. Manganese ore produced abroad in captive mines, or imported directly by the consumer, never did come under the price ceiling. Only foreign manganese handled by a broker was subject to OPS supervision—not enough of the inflow to make controls effective.

The important aspect of this move is what it shows about policy. The manganese price ceiling definitely was not ended because OPS wanted to come to the aid of the domestic mining industry with a higher price. It did not make the decision in order to help expand domestic output, as some interpreted it. It would be a mistake for the mining industry to assume, on the basis of the manganese decision, that a policy of higher prices was being inaugurated.

International Allocations

Great Britain's sulphur shortage was getting the headlines when London sent Richard Stokes to this country on an official shopping tour for scarce materials. But it was molybdenum which apparently was No. 1 on Stokes' list. When he got back to London, he said he had spent most of his time in this country talking about moly—and he had a 1,250,000-lb. export quota for the second quarter to show he had not wasted his breath. This is a 40% increase over the amount exported in the first quarter, and more than was exported pre-Korea. It is not as much, however, as was going abroad in 1950, when the steel industries of Great Britain and Western Europe had begun to turn to moly as a substitute for tungsten, cut off by Communist China.

British Victory

The size of the export quota is more of a victory for the British than comparison with 1950 would indicate. Exports had fallen to a trickle, beginning with March of this year, and continued at a low rate during the first two months of the second quarter. So the husky second quarter quota fell with double impact on June supplies. Domestic users were cut back to make up the quota.

Sulphur is another indicator of the scale at which international allocations are likely to be established as shortages become more acute abroad. The export quota for 1951 will be 17% of U. S. output, compared to about 25% before the Korean war.

Two commodities don't establish a pattern—but the quotas for moly and sulphur indicate that the mobilization chiefs in this country are willing to give up important amounts of key materials to help mobilization abroad.

Business and industrial leaders of the Western allies, at Lisbon for meetings of the International Chamber of Commerce, talked a good part of the time about the dangers of raw material shortages. They heard a report which put some of the world's mineral needs in these terms: 20% more copper; almost as much more sulphur; 12% more zinc.

The International Materials Conference has issued a statement urging that tungsten and molybdenum should go under allocation during the third quarter of this year. The Conference's Copper-Zinc-Lead Committee has agreed to recommend international allocations in the fourth quarter. These are signs that a policy may yet emerge. Shortages are forcing it.

The mining machinery industry was allotted 60,000 tons of steel for the third quarter of the year—and was assured a place as one of 11 top defense supporting industries. The select list includes such key programs as that of the Atomic Energy Commission, utilities expansion, and railroad equipment. In terms of steel tonnage, mine machinery was smallest on the list. But its place there gives assurance that mining will be given high priority consideration under the Controlled Materials Plan, which took over July 1.

MRO Revisions

The new and liberalized rules for ordering maintenance, repair and operating supplies (MRO) are part of the basic policy of the Controlled Materials Plan. Under this same policy, the mining industry should find industrial equipment suppliers well stocked with standard parts, components, and tools. But based on recent experience, doubt is justified that the policy will work well.

The new MRO regulations allow the DO-97 symbol on orders up to 120% of either the calendar year 1950, or the nearest fiscal year ending before March 1, 1951. You can choose whichever base period gives you the most freedom. NPA knocked out the former 100% limit for two reasons: Prices have gone up and business has expanded. It provided a 10% increase for each of these trends, and came out with the new 120% ceiling.

The relative liberality for MRO supplies and components, as expressed in the new orders, will be a part of the Controlled Materials Plan as it takes over more and more of the economy. An essential of that plan, as its top policy-makers see it, is to provide mining and other basic industries with plenty of the odds-and-ends needed for full production. It doesn't make sense to provide special allocations of scarce materials for mining machinery—as an example—then hamper production by not having a full supply of MRO supplies.

The question over whether the policy will work is justified by experience with the MRO situation so far. As most mine operators have discovered, the DO-97 for MRO supplies has been pretty much kicked around by manufacturers. It is supposed to be as good as any other DO—as one for tanks, or ships, or guns. But it hasn't worked out that way. In practice, manufacturers often put the DO-97's they received on the bottom of their piles of orders.

On paper, at least, CMP should give full face value to MRO orders. What happened in the past several months was that manufacturers created their own unofficial rating of DO's because they couldn't get material enough to treat all orders equally. They didn't want to endanger their contracts with the military or defense-

supporting industries, so the DO's for MRO supplies took the rap.

Unfortunately. the confusion of the past several months is going to continue, at least through the third quarter. CMP was so late getting started, that its allocations for materials don't have to be accepted by steel producers until Sept. 1. This means the fourth quarter before end products come under full CMP procedures.

Mineral Subsidies

If and when Congress sits down to consider a revised Defense Production Act, it will have before it a recommendation of the National Minerals Advisory Council regarding mineral subsidies. The recommendation asks that subsidies, if used to stimulate increased production, be applied on a uniform basis to all new or increased production above a base period. The base suggested by the Council was 1946-49. When we went to press, the House Committee still had subsidy-enabling language in the bill.

Congressional sentiment for an extension of the Defense Act of 1950 without change increased steadily as the long parade of witnesses for and against controls appeared before the Senate and House Banking Committees. It wasn't anything the witnesses said that influenced Congressmen—for the most part, they were simply repeating old arguments. But Congressmen began to see that if they simply shoved a decision on controls into the future, events might make the writing of a new law, or killing of the present one, much easier.

Brief, but Important

ASSESSMENT WORK — bills have been introduced in both House and Senate to extend the July 1 deadline for fiscal 1951 to October 1 or November 1.

EXPLORATION PROJECTS — On June 29, Defense Minerals had 37 signed, making a Government commitment of $1,589,901, and 15 more near signature. There was hope that Congress would extend unexpended fiscal 1951 funds beyond July 1. DMA is handicapped in handling applications because of non-cooperation of applicants in giving necessary information, particularly locations of projects and simple sketch maps.

TAX RELIEF—House passed tax bill containing provision that development expense could be recovered independently of percentage depletion pro-rata according to extraction of affected tonnage.

TUNGSTEN BACKDOWN — Announced 5-year guarantee of $63 domestic price to all who applied before July 1, 1951, is now hedged by overall limitations of 7 million short-ton units.

LABOR THIS MONTH

Joseph M. Gambatese, McGraw-Hill Washington News Bureau

WHITHER MINE-MILL? This union has won many NLRB elections handily. Thus far, however, the job has been mainly one of fending off CIO and AFL raids. Mine-Mill leaders feel confident they can hold their membership. In fact, they now itch to do a little raiding of their own. But close observers don't think Mine-Mill's switch from defense to offense can be very successful.

COMMIE LINE: Mine-Mill's strict adherence to the Communist Party line remains a big handicap where the union is not entrenched. The union still gets big headlines in the Daily Worker. The latest: Mine-Mill officers' support of Senator Johnson's resolution for cease fire and armistice in Korea.

UN-AMERICAN ACTIVITIES: One of the first witnesses questioned by the House Committee on Un-American Activities in its investigation of Communist labor leaders in defense plants was Walter McManamon. An organizer for Mine-Mill at Perth Amboy, N. J., McManamon was questioned principally about his activities in Baltimore, where he worked in shipbuilding and headed the Baltimore CIO council. He refused to tell the committee whether he is a Communist or whether Communists helped him get the Mine-Mill job a few years ago. This recalls the CIO report attacking Secretary-Treasurer Maurice Travis for letting the Communist Party interfere with the union administration.

MANPOWER: It's awfully tight in mining, will get tighter. Engineers, in particular, can't be found. There's talk in Washington of deferring all engineers. But it's just talk. With no manpower controls in sight, more reliance will have to be placed on higher wages to hold or attract miners and workers in other critical industries. Wage stabilizers encourage this.

WORKWEEK: Manpower authorities oppose abolition of time-and-a-half overtime after 40 hours. Look for a policy—as during the war—of moving gradually to a longer workweek where manpower conditions warrant. Forty-four hours will be encouraged, where possible. Maximum, under partial mobilization, should be 48 hours, planners say. But much of copper mining already is working 48 hours or longer. This is evident from the average of 46.4 hours in April. Shorter hours for clerical workers, absenteeism and tardiness bring the average below the scheduled week. Averages for others above 40: aircraft, 44.2; electrical machinery, 43.7; primary metal, 41.7; and durable goods manufacturing, 41.8.

IRON MINES: U. S. Employment Service sees no significant manpower problems in iron mining. It expects employment to expand this summer, with recruitment "generally easy." It also finds iron mining labor turnover lower than in metal mining in general.

MINING STRIKES: At Coleraine, Minn., Cleveland-Cliffs' iron mining operations were halted when CIO miners "went fishing." The grievance: company delay in improving working conditions as contemplated in contract. At Silver City, N. M., wives of Mine-Mill strikers at Empire Zinc operations were jailed for blocking a highway. Trouble began when the company offered a 15-cent wage increase, luring back some of the workers who have been on strike seven months.

BIG WAGE INCREASE: That's what Mine-Mill got from International Nickel Co. at Sudbury and Port Colborne, Ontario. It adds up to 22 to 27 cents an hour, like this: general increase of 10 cents an hour, on top of cut in workweek from 44 to 40 hours with no reduction in take-home pay.

WAGE POLICY: It will be flexible, permit sixth-round increases for steel and coal mining above cost of living. Major bases for increases will be these:

1. To offset increased cost of living. 2. To compensate for increased productivity—but not more than 2% or 4 cents per hour—where employer promises to ask for price increase. 3. To keep you from losing employees to competitors by correcting interplant wage inequalities. 4. To correct internal wage relationships through individual adjustments. 5. To obtain manpower in tight labor areas.

SALARIES: Salary Stabilization Board of all-public members is handling them. Salary boosts up to 10% above January, 1950, don't require approval. But you might get an O.K. for more than that if the average for your executive group is not more than 10%, if it is justified on merit, or if new duties are added to the job.

VIOLATIONS: Be careful of violating wage and salary restrictions. The entire unapproved wage or salary may be disallowed as a cost for income tax, price or other purpose in dealing with the Government. Also, any priorities or materials allocations you possess might be withdrawn.

MARKETS—Trends and Prices *(Continued from page 85)*

Copper Statistics

Following is a summary of the latest copper statistics issued by Copper Institute covering the January-May period of 1951, in tons:

United States

Production:	Jan.	Feb.	March	April	May
Crude, primary	81,737	78,431	85,060	83,417	90,054
Crude, secondary	5,224	3,167	6,183	7,377	6,771
Totals	86,961	81,598	91,243	90,794	96,825
Refined	110,144	101,054	112,933	103,494	113,513
Deliveries, refined (a)	108,128	99,485	116,793	114,744	118,113
Stock at end	54,883	59,324	55,609	52,800	60,896

(a) Exclusive of stockpile deliveries.

Outside United States

Production:	Jan.	Feb.	March	April	May
Crude, primary	114,267	108,318	118,925	117,707	115,267
Crude, secondary	284	348	216	259	258
Totals	114,551	108,666	119,141	117,966	115,525
Refined	97,599	90,156	100,946	104,831	97,004
Deliveries, refined	71,597	71,467	80,050	87,829	92,505
Stock at end	146,837	151,288	161,720	164,588	150,549

Official London Prices

Consumers in the United Kingdom obtain copper, lead and zinc at prices named by the British Ministry of supply. Delivered prices in effect as June ended were as follows:

	Per Long Ton £	s.	d.
COPPER:			
Electrolytic, high conductivity	234	0	0
Fire refined, high conductivity	234	0	0
Fire refined, high grade	233	10	0
Fire refined, min. 99.7 percent	233	0	0
Fire refined, min. 99.2 percent	232	10	0
LEAD:			
Soft, foreign duty paid	160	0	0
Soft, Empire	160	0	0
English, refined	161	10	0
ZINC:			
Foreign (G.o.b.) duty paid	160	0	0
Domestic (G.o.b.) duty paid	160	0	0
Prime Western and debased	160	0	0
Refined and electrolytic	164	0	0
Minimum 99.99 percent	166	0	0

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York unless otherwise stated

MISCELLANEOUS METALS

June 30, 1951

Aluminum, ingot, 99 plus percent, lb. (base price)	19c.
Antimony, spot, lb., 5 tons and up but less than carload in cases	45.300
Bismuth, ton lots, lb.	$2.25
Cadmium, commercial sticks, delivered, lb.	$2.55
Calcium, lb., ton lots, 98 percent, cast	$2.05
Chromium, 97 percent grade, lb., contract	$1.07
Cobalt, 97 to 99 percent, per lb.	$2.10
Indium, troy oz.	$2.25
Nickel, cathodes, lb., f.o.b. Port Colborne (a)	56½c.
Magnesium, 99.8 percent, carloads, lb., producer's plant, Freeport, Texas	24½c.
Palladium, troy oz.	$24.00
Platinum (Official quotation wholesale lots) troy oz.	$90.00
Quicksilver, flask of 76 lbs., 25 flasks or more	$ 210@ $213
Selenium, 99.5 percent, lb.	$3.00
Silicon, minimum 97 percent, spot, carloads, lb.	20c.
Tellurium, lb.	$1.75
Thallium, 100 lb. or more, lb.	$12.50
Titanium, 96 to 98 percent, lb.	$5.00

(a) Includes U. S. duty.

METALLIC ORES

Beryllium Ore, imported, 10 to 12% BeO, per unit	$28.00
Chrome Ore, per long ton, f.o.b. cars Atl. ports, dry	
44% Cr_2O_3, no ratio	$27.00 @ $28.00
48% Cr_2O_3, 3 to 1 ratio	$43.00 @ $50.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$8.70
Mesabi bessemer	$8.45
Mesabi, non-bessemer	$8.30
Lead (Galena), 80 percent, Joplin, Mo., ton	$218.42
Manganese Ore—Per long ton unit of Mn basis 48 percent manganese, nearby positions, subject to premiums and penalties, $1.10., c.i.f. U. S. ports, duty extra. Long-term contract quotations wholly nominal and matter for negotiation.	
Molybdenum Ore, 90%, per lb. of MoS_2 f.o.b. mines	60c.
Tantalite, 60% concentrate, per lb.	$2.00 @ $2.50
Tungsten Ore, per unit of WO_3	
Foreign, 60 percent, U. S. equivalent, duty extra	(a) $65.00 @ $67.50
Domestic, scheelite, 60 percent f.o.b. mine	$65.00
Vanadium Ore, per lb. of contained V_2O_5 f.o.b. mines	31c.
Zinc Ore, Prime, 60 percent concentrate, Joplin, Mo., per ton	$115.00

(a) Nominal.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic trioxide) lb., in bbl. carload lots delivered	6½c.
Cobalt Oxide, 72%, metallurgical grade, per lb. of Co	$2.25
Copper Sulphate, 100 lb.	$8.95

ALLOYS

Beryllium Copper, 4 percent Be, per lb. of alloy, 5 lb. ingot	$1.56
Ferrochrome, 65 to 69 percent, per lb. of Cr contained	21¾c.
Ferromanganese, 78 to 82 percent, gross ton, seaboard	$185.00
Ferromolybdenum, 55 to 65 percent Mo. lb. of Mo. contained	$1.32
Ferrosilicon, 50 percent, per lb. of contained Si	12.4c.
Ferrotungsten, 75 to 80 percent, lb. of W contained	$5.00
Ferrovanadium, per lb. of V delivered	$3.00 @ $3.25
Silicomanganese, max. 1½ percent carbon, per lb. contracts	9.9c.
Spiegeleisen, per long ton, 19 @ 21 percent grade	$75.00

NON-METALLIC MINERALS

Asbestos, f.o.b. Canada (Quebec) mines (U. S. funds), ton:	
Crude No. 1	$960 @'$1,500
Crude No. 2	$595 @ $900
Spinning fibers	$275 @ $475
Shingle fibers	$123 @ $170
Paper stock	$85 @ $119
Waste	$63 @ $70
Shorts	$30 @ $63
Asbestos, Vermont, f.o.b. Hyde Park:	
Spinning fibers	$254.10 @ $274.45
Shingle stock	$122.65 @ $148.50
Paper stock	$86.90 @ $106.15
Waste, stucco or plaster	$64.90
Refuse or shorts	$31.20 @ $57.60
Barytes, f.o.b. mines:	
Georgia, crude, per long ton	$13.00 @ $13.50
Missouri, 93 to 94 percent $BaSO_4$, per short ton	$9.25 @ $9.50
Bauxite, long ton, f.o.b. point of shipment:	
Domestic, crude, 50 to 52 percent (not dried)	(a) $4.50 @ $5.50
Domestic, chemical, 55 to 58 percent	(a) $8.50 @ $9.50
Domestic, abrasive, 80 to 84 percent	(a) $18.00 @ $18.50
China Clay, f.o.b. mines, ton:	
Georgia, filler and ceramic grades	$8.50 @ $9.50
North Carolina ceramic grade	$20.25 @ $22.25
Feldspar, bulk ton:	
Potash or soda feldspar, 200 mesh, ceramic grade	$18.50 @ $22.25
Glass feldspar, white, 20 mesh	$11.75 @ $12.50
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois, 70% effective, CaF_2, ton	$43.00
Acid 97% concentrate, bulk, ton	$50.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00 @ $14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington	$36.30
Mica—Domestic, f.o.b. mines. Punch 12 to 22c. per lb. according to size and quality. Sheet, clear, 1½ x 2 inch, 80 to 85c.; 2 x 2 inch, $1.10 to $1.20; 2 x 3 inch, $1.50 @ $1.60; 3 x 3 inch, $1.80 @ $1.90; 3 x 4 inch, $2.20; 3 x 5 inch, $2.40; 4 x 6 inch, $3.15; 6 x 8 inch, $4.25. Wet ground, very fine, $140 @ $155 per ton. Bulk sales, dry ground: $32.50 @ $70.00 per ton. Scrap, $32 and up.	
Ocher, Georgia, ton, in sacks	$24.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 14c.
Sulphur, Texas, mines, long ton	$22.00
Talc, f.o.b. works, ton:	
New York, purified	$18.50 @ $20.00
Vermont, extra white	$12.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$30.00

(a) Nominal.

IRON AND STEEL

Pig iron, gross ton, basic, Valley furnaces	$52.00
Steel, f.o.b., Pittsburgh billets, net ton	$56.00
Structural shapes, 100 lb.	$3.65

We Mobilize for Freedom

CONTROLS . . . A Two-Edged Sword

It may seem dangerously premature to talk about getting rid of emergency government controls while all-out war is still an imminent possibility.

But success in this strange struggle for our freedom into which the Russian Communists have plunged us requires that we:

1. Maintain a whole battery of controls designed to speed defense production and curb inflation, and at the same time

2. Work to end the controls at the earliest possible moment.

Here is the reason why this editorial—fourth in a special series on mobilization for defense—is devoted to the need for a speedy release from controls.

If the Russian Communists can force us to maintain indefinitely the present system of government controls, they will have won a tremendous victory. They will have saddled us with a system of collectivism which, over a period of years, would be fairly certain death to freedom of business enterprise.

Make no mistake about it. This is not an argument against emergency controls. We need controls now to break a right of way for our mobilization program through the business boom. Indeed, the third editorial in this special series was titled "Why Controls Are Necessary." It stressed both the need for controls and the need for positive cooperation to make them work.

Controls Can Undermine Our Economy

But these controls surely chisel at the foundation of our normal economic system. So long as we have them, many if not most key business decisions will be made in Washington bureaus rather than in the free market place. For example, the *National Production Authority* administers a *Controlled* Materials Plan (italics ours) which directs the flow of basic metals, and decides who can use them for what purposes.

Happily, the people who operate these controls are not using the methods of a secret police state.

Even more happily, most of the leaders who have been drafted to manage the controls are not in love with their jobs. They are doing their best in the thankless task of making controls work. They recognize the danger of chronic controls.

But the fact remains that our economy is

operating under arrangements which carry it a long way toward the pattern of centralized control the Russians would inflict on the world.

The Wilson Plan

A plan for getting rid of these controls has already been developed. It was put together by our Director of Mobilization, Charles E. Wilson—while he was working day and night to set up the necessary emergency controls.

The Wilson Plan—if we escape all-out war—will strengthen our defenses and our economy. By 1953, it calls for:

1. Providing the weapons to equip an armed force of 3½ to 4 million, together with a supply of weapons for our allies.

2. Building a stockpile of weapons which, with current production, would be sufficient to carry on an all-out war for a year.

3. Building the manufacturing capacity by which we could rapidly expand our production of weapons if all-out war should come.

4. Increasing the productive capacity of industry enough to resume the expansion of our civilian economy.

With these jobs done our economy would be big enough and strong enough to meet both civilian and military requirements. And the government controls needed for mobilization could be speedily dropped.

Call for Sacrifice

The Wilson Plan requires a major effort—it means spending more than $50 billion a year for mobilization. That is almost 20 percent of our total production. And this cannot be done without sacrifice. For a time, particularly in the next year, living standards will drop.

But the sacrifice required is amazingly small. At the peak of the defense effort, civilians will still have available to meet their needs about as much as they did in any year before 1948.

To make the Wilson Plan succeed we must curb inflation. A second year of inflation such as that which we have had since the Korean war started would multiply disastrously the costs of our defense program. One key part of a successful program to curb inflationary pressure, which soon will be building up again, is a pay-as-we-go tax program. The second editorial in this series urged that we do our utmost to pay as we go.

We Cannot Out-Control the Communists

But, above all, to make the Wilson Plan work we must keep our sights set on the crucial importance of increased production. Our problem is to increase our capacity to produce so that we can carry both a major military program and an expanding civilian economy for as many years—General Bradley thinks it might be fifteen or twenty—as the menace of Russian Communist aggression persists.

If we do not produce enough to do this double job, we shall be confronted with the prospect of having to live indefinitely under government controls of the sort that have been set up since the start of the Korean war. That would be delightful to the Russian Communists. It would go far toward making over our economy on the Moscow model.

Even if we wanted to, we never could hope to out-control the Russians. They are miles ahead of us in that line. But we can out-produce them, by a tremendous margin. By doing that we shall travel the surest road to victory.

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THIS MONTH IN MINING

Here is a quick report from E. & M. J.'s correspondents on how the mining industry is handling its defense production job, here and abroad.

IN THE UNITED STATES

ARIZONA

Phelps-Dodge completes smelter, plans Bisbee project —Smaller mines reopen as demand grows

★**Arizona mining** took a multimillion dollar forward step in 1950.

The records show tremendous expenditures on the part of the major operators, and a flurry of activity among small miners and processors as higher metal markets made it profitable to reopen workings.

During the year, **Phelps Dodge Corp.** completed a $7-million smelter at Ajo, opened work on a $25-million open pit at Bisbee, and spent huge additional funds in building modern homes for their employees.

Magma Copper Co. announced it had spent $8 million in development work on the San Manuel mine near Oracle, a copper development that will require an estimated $100 million to bring to full production.

Small operators in Mohave, Yavapai, and Santa Cruz counties stepped up operations under the national defense program as demand for zinc, lead, copper, and silver mounted.

★Exploration work at the gigantic **Artillery Peak** manganese deposit 20 mi. south of Bagdad in Mohave county continued to supply the $600,000 pilot plant at Boulder City, Nev., which will handle ore from the deposit.

The deposit is rated as the largest manganese working in North America. Known since World War I, it previously was considered to be of too low grade to be profitably worked. At the Boulder City plant, the 16% average ore will be concentrated to 40% for commercial use.

★**Phelps Dodge Corp.**, which has acquired an additional 5,000 acre-ft. of water to supply its Clifton-Morenci workings near the New Mexico line, a water carry of more than 100 mi. from northeastern Arizona, got under way with its biggest development of the year at Bisbee in Southern Arizona.

Named the Lavender Pit in honor of the vice-president in charge of mining operations for PD, the new open pit will require $25 million and two years' development. About 350 ft. of waste must be removed to get at the orebody. The pit will be 2,000 x 3,800 ft. across.

It is located at the site of a former town. Three hundred residences were moved, and a new business district built.

★At the mountain-locked community of Ray, in northern Pinal county of Central Arizona, **Kennecott Copper Corp.** moved closer to a goal of 10 million lb. of copper production monthly. The goal is the result of a $30-million expansion that will extend operating life indefinitely, increase ore production 15,000 tons a day, and add hundreds of workers to the pay rolls.

Much of the development cost was devoted to stripping, a three-year operation started when underground workings became too expensive.

Along with the pit development, Kennecott has increased mill capacity 50% at Hayden and provided diesel equipment for the railroad linking the two towns.

★**In northern Arizona,** Geiger counters clicked new finds, mostly on the Navajo reservation, and the Indians were enriched $160,000 during the year from uranium royalties.

Meanwhile, the tribal coffers were prepared for a new flow of revenue. The Vanadium Corp. of America was exploring new deposits and the Indians have made contracts for construction of a mill on the reservation to handle concentrates. **The Lukachukai basin** south of Red Rock has been termed among the richest in the nation by Dr. Phillip L. Merritt, assistant director of the division of raw materials for the Atomic Energy Commission. Deposits are estimated at about 0.4% carnotite.

★Production for the **Iron King mine** in Yavapai county of North Central Arizona totaled 200,000 tons last year, bringing total production of the workings to 1,500,000 tons, according to Hap Mills, general manager.

Of the 1950 production, there were 20,000 oz. of gold, 800,000 oz. of silver, and 10 million lb. of lead—each representing 1% of the national output for those minerals, and 20 million lb. of zinc, approximately 2% of U. S. zinc production.

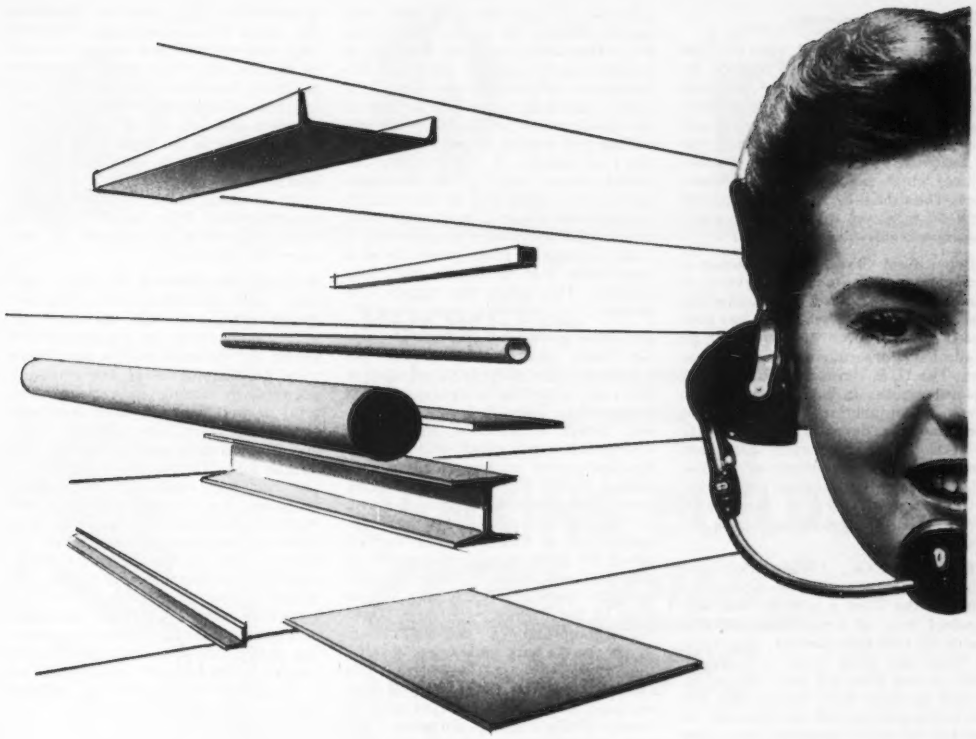
COLORADO

Carlton mill ships first gold —Leadville tunnel hits ore— Six minerals now produced at Climax

★Gold is flowing again in the historic **Cripple Creek-Victor** district in Colorado. Gold from 6,000 tons of ore milled since March 12 was made into two gold bricks May 23 at the new Carlton mill in the district, which started operations March 12. The mill replaces the Golden Cycle mill at Colorado Springs, Colo. One of the bricks weighed 1,208.8 troy oz. and was valued at more than $35,000. The other weighed 970.8 oz., valued at more than $28,000. The mill has been handling 400 to 500 tons of ore in a three-shift day. Present at the pouring of the first bricks were: Merrill Shoup, president of the Golden Cycle Corp., owner of the Carlton mill; Max Bowen, general superintendent; and Mrs. A. C. Magruder, a member of the board of directors.

★Colorado metal mines are speeding operations to help supply the nation with strategic and critical metals needed in its armament program. The zinc shortage has caused **Empire Zinc Co.** to push operations at its famous Eagle mine at Gilman and its 600-ton underground flotation mill. Officials of the Empire Zinc Co., a subsidiary of the New Jersey Zinc Co., report that ore deposits in Battle Mountain have only been "scratched." There's enough ore, they say, to last several generations. The mine is the largest producer of zinc in the state; it was also the largest producer of silver and an important producer of lead, gold and copper.

★**The U. S. Government** is cooperating with Leadville miners to start a new era of ore production for defense. The Leadville drainage tunnel to unwater the lead and other strategic ores at depth in the Cloud City mining district is being pushed ahead. John H. East, Jr., regional director of the U. S. Bureau of Mines, says that at the 8,573-ft. mark crews driving the tunnel encountered a 15-in. fissure vein along a small fault that assayed from 90 to 200 oz. of silver to the ton and more than 50% lead. Ore also contained 3% zinc, 1.9% copper, and 0.09 oz. of gold. Government experts



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Colorado *(Continued)*

believe the tunnel will open up the nation's biggest lead-zinc reserve deposit and will increase the lead-zinc ore tonnage production by one-third. East said that in June the tunnel will reach the Robert Emmett shaft, one of Leadville's richest and most famous mines, which holds 200 ft. of water above the tunnel level and is connected with 50 miles of underground workings now water-filled.

★**Below Gold Creek near Gunnison** is located one of the newest ventures in the county. **Beryllium, Inc.,** under the direction of C. A. Wemlinger, has produced a little over 30 tons of high grade beryl ores during the past season. The U. S. Bureau of Mines spent several months in core drilling these areas in conjunction with Beryllium, Inc., and the Brown Derby property holders. These pegmatite dikes are yielding minor quantities of columbite, samarskite, tantalite, and radioactive minerals of the rare earth series which are vitally needed in the atomic field.

★**Beryl Ores Co.,** Arvada, Colorado, mined and purchased from mine operators of the West a total of over one hundred tons of beryl last year for use in its mill near Denver. The price of beryl has risen from only $35 in 1939 to over $300 per ton. The prices quoted in New York for foreign ore are being paid in full in Colorado. A number of mine operators who once considered beryl as a minor by-product are now operating primarily for beryl, with such items as scrap mica and feldspar being considered by-products. While the beryl of commerce is specified as ore of a minimum of 10% BeO content, Beryl Ores is purchasing and milling in Colorado ore of only 2.5% BeO content.

★Greater development for new ore production for defense is noted in the San Juan mining region of southwest Colorado. Homestake Mining Co. has acquired an interest of approximately 10% in the big Idarado Mining Co. operating the Treasury tunnel at Ouray. Homestake has also acquired a 20% interest in the Atlas Mining Co. Both deals were made with Newmont Mining Corp., which before the transfer owned 87.5% of Idarado Mining Co. and 100% of Atlas Mining Co.

★Another chapter in the history of the progress of mining in Colorado is being written at **Telluride Mines, Inc.** in the San Juan region. This came when the mill level tunnel started in 1945 was joined with the upper workings by the completion of an ore pass. The tunnel has cut the Smuggler vein about 2,300 ft. from the portal. At 7,120 ft. from the portal, the Montana vein was cut. Here the fissure was strong but mineralization was poor. The tunnel and ore pass have proven ore below the Penn level.

★Operations conducted by **Rico Argentine Mining Co.** during 1950 at its properties located at Rico, resulted in outstanding production progress, according to information contained in a recent report to stockholders. Due to low metal prices, full scale mining and milling was carried on only during the last four months of 1950. During the period of low metal prices, improvements were made and an accelerated development program was carried on. This helped materially in producing a large tonnage of good grade ore at a reasonable cost in these last four months. This large ore output continues.

★**Electric power consumption** at Cripple Creek showed an increase for April over the other three months of this year, according to figures released by Southern Colorado Power Co. Several power connections were made during the month which will not only increase power consumption but also mining in the Cripple Creek district. Among the power loads connected are: A transformer station for a 60-hp. compressor at the Anaconda Tunnel; power for hoist and fan on the 900-ft. level of the Joe Dandy mine; a power cable for hoist and fan on the bottom level of the Strong mine; and power for a compressor at the Gold King. There are 15 sets of lessees working the Cresson now and their shipments are approximately equal to those from company workings. The Ajax mine of Golden Cycle Corp. is shipping 1,300 tons of gold ore weekly to the mill. Several smaller mines are also shippers.

★**Old Hundred Gold Mining Co.** is nearing the point of turning out concentrates at its mill in Cunningham Gulch near Silverton. Power connections have been set up and test runs made. General manager Ben F. Webster, Jr., looks forward to a successful milling and mining operation this summer.

★L. E. Stein, vice president and manager of **Silver Shield M. & M. Co.,** reports that the company mill located at Ouray was finished last month. The **Wanakah Leasing Co.** has a lease on the Wanakah mine to deliver the ore to the mill for a period of eight years. There is also custom ore reported available for the mill which is a 250-ton flotation plant.

★**King Lease, Inc.,** has extended the inclined raise at the Camp Bird mine at Ouray to the old Camp Bird fifth level, thereby making another exit from the mine possible. A compressor room was excavated and compressors were installed underground. Tracks in the main crosscut were re-laid with 65-lb. rails replacing the old lighter weight rails. The property, under the management of **Minerals Engineering Co.,** is directed by Norman D. Ebbley. Approximately 75 men are employed, producing 100 to 125 tons a day of lead-zinc-gold ore.

★**American Zinc, Lead & Smelting Co.,** under the management of Marvin Kay, has operated one unit of its mill on custom ores from small operators in Ouray and San Juan counties. This has been of value to the several small shippers and may prove to be the deciding factor in the start of an important producer. **San Juan Metals** has operated the Mickie Breen with a crew of seven men. It has produced approximately fifty tons a week of lead ore, which is shipped to the American Zinc mill.

★**Climax Molybdenum Co.** has a contract with the Government that requires mine and mill operation at maximum capacity for a period of five years. At the start of the year there were 470 employees of the company engaged in mining operations. The total payroll has now been increased to 768 employees. The orebody is estimated to contain ore reserves of 250 million tons. The by-products plant of the company continues to produce tungsten, tin, monazite, topaz, and pyrite. Considerable research has been done and will be continued in an endeavor to secure the maximum recovery of by-product minerals which exist in the company's deposit. It is contemplated that the present by-products plant, which is capable of processing 10,000 tons of tailings, will be expanded in the future to such extent as is necessary to handle all tailings coming from the mill.

IDAHO

Deep discoveries gain new importance—Bunker Hill resumes block caving — Atlas explores East Silver Belt

★The idea of a "have-not" nation does not apply to the Coeur d'Alene mining district of northern Idaho. Given the necessary manpower and a fair market price for lead and zinc, the district can produce a monthly average of more tonnage of these strategic minerals than ever before.

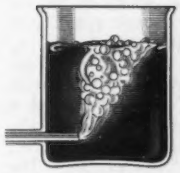
During World War II the district was handicapped by a labor shortage; low, controlled metal market prices; difficult-to-get supplies and repair parts of all kinds. Therefore mineral production from the district was reduced to a minimum.

Since that time the district has returned to somewhere near maximum output although still handicapped by a shortage of skilled labor, and has greatly increased its production area. This was first demonstrated at the Sunshine mine where four important parallel veins were opened at various depths down to the 3,800-ft. level, and geological conditions found to be favorable for still greater depth.

(Continued on page 176)

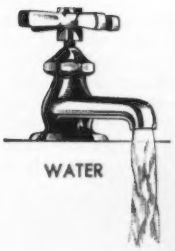
OIL

GAS

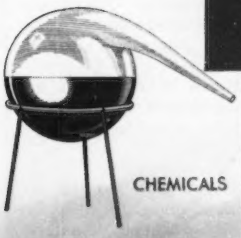


AIR

STEAM



WATER



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PRODUCTION FOR DEFENSE — In the Shop

(*Continued from page 149*)

quate inspection schedules or establishing the economic quantity of spare equipment.

Spare motors is an excellent example. We recently were faced with the question of whether or not a spare 500-hp. motor should be provided for the ball mills to protect continuous grinding operations. The cost of a new motor would run as high as $9,000. By temporarily using an existing 300 hp. spare motor in the event of a breakdown, the mill, by sacrificing some capacity and fineness of grind, could get by while the original motor was being repaired. Therefore, we decided that there was no economic justification for setting the service factor so high that it demanded a spare 500-hp. motor be kept on hand.

This type of example can be applied practically to all machinery in the plant. To button up this situation we had to find the answers to these questions.

(a) What type of equipment must have spare standby equipment and extensive preventative maintenance inspection to prevent critical plant shutdowns?

(b) What equipment can be maintained simply by non-scheduled work orders from the operating personnel?

(c) What maintenance work on general equipment throughout the plant can be pre-planned in advance, and held for standby or fill-in jobs that can be taken care of when the shops are not busy on emergency work?

These service factors established, the next step was to reduce the cost of maintenance wherever possible by improving our job methods, by better work scheduling, by closer planning in the allocation of manpower, and by more economical use of materials.

This step takes in a lot of territory, and is continuous. Before we could go further we had to examine our existing methods and distribution of work force. Discussions were held between top shops' supervision and the Production Engineering Department to agree on the division of work, shop loading, type and amount of control measures desirable over planning of the work, material handling, and work force requirements.

A study of the actual methods by which work orders were processed from their point of origin to final completion was made. The vast majority of all issued orders were going direct to the foreman without any reference to either the Master Mechanic or Mechanical Superintendent. A large percentage of work was started on verbal orders from mine and mill shift bosses having very loose authority to issue such orders. Over a one week period, as many as 30 percent of all orders issued were given verbally, 7 percent were telephoned in, and only 63 percent of the total were issued on properly authorized written forms. A large percentage of these written orders lacked full information concerning the work, when the equipment would be available, or when it was required to be back on the job in the mine.

Lack of system provided no check on whether or not a large percentage of orders being issued were properly authorized. There was widespread inconsistency in the division of the work among the various shops, and finally, the lack of controlled procedure left top shop supervision without any direct central control point from which they could determine the work load or determine optimum manpower requirements.

We finally decided to set up a central dispatch office through which all maintenance work orders would be routed. This eliminated the many existing faults and in addition had many advantages listed above.

2. Here's How We Organized the Central Dispatch System

I. WE WROTE UP the proposed procedure so that all men involved would understand exactly what was to be done. This bulletin classified the types of work done by the shops.

1. Standing Orders. A standing order calls for routine work such as changing light bulbs, snow removal, road maintenance, operating hoists, etc. Orders to vary the routine of a standing order may be given verbally to the Central Dispatching Office. Only CDO will issue new standing orders.

2. Preventative Maintenance Inspection and Repair. Preventative Maintenance schedules will be developed by the Service Division and coordinated with the operating departments. This work will be automatic and will not require written orders from the equipment operators.

3. Emergency Breakdown Jobs. Orders for this work must be handled as expeditiously as possible. It will be left to the discretion of the calling party as to whom he should contact for the quickest action. Original verbal orders must be followed by a confirming written order.

4. Regular Work Orders Not Covered in Classifications 1, 2 and 3 must be submitted, in triplicate, to the Central Dispatching Office on a work order form. It will be each department's responsibility to see that a realistic delivery date is put on each order and that work is requested as far in advance of the required completion date as is possible.

5. Major Projects Requiring Management Approval and/or Engineering Work will continue to be routed through the Plant Engineer's Office.

II. It seemed essential to establish definite lines of authority for issuance of work orders. A general meeting of all department heads was therefore called and the plan outlined to them. Agreement was reached in principle on the establishment of service factors on preventative maintenance. Cooperation, without which the plan could hardly succeed, was pledged by all departments issuing work orders on the maintenance shops. Stress was placed on:

(a) Strict departmental control over issuance of emergency work orders in order to keep these to a minimum.

(b) Issuance of a list of all persons in each department who are authorized to issue work orders and the total dollar value to which they could order work without higher approval.

(c) Insistence that as soon as the Central Dispatch Office was operating, no maintenance work orders (except emergency) would be issued direct to shop foremen.

(d) Insistence in future that no verbal or telephoned work orders issued to shops would be accepted (except emergency).

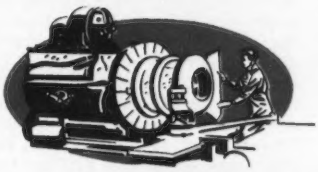
III. All Shops' foremen should be given every opportunity to study and appreciate the benefits to be gained by central dispatching of work orders and understand the procedure for handling same.

IV. An analysis and job descrip-

(*Continued on p. 166.*)

"It ain't the individual nor the army as a whole
But the everlastin' teamwork of every bloomin' soul."

Excerpt from "Cooperation"
by J. Mason Knox



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tion of the Dispatcher's work was drawn up so that we could select a good man for the job. The man should have a good general knowledge of shop practice, machine loading, and preferably one with experience in our own shops.

Duties of the Dispatcher are:

To check work orders for proper authorization, completeness of required information given with them.

Code work orders for cost machine tabulation, prepare sub orders for work required by two or more shops, analyze work orders, procure drawings and material.

Issue work orders to the various trades foremen, assist in preparation of long range work schedules to determine future manpower and machine tool requirements, compile statistical data and prepare reports to show the work situation in the shops.

V. Development of a standard work order form for all jobs.

Although there were "bugs" to be worked out in the early operation, the Central Dispatching system is running successfully.

3. We Start on Cost Control

HAVING ESTABLISHED CENTRAL dispatching of work orders, the third and final important step in our program, the application of cost control, could begin to function smoothly. Stated very broadly, the objective was to keep construction and maintenance expenditures within established limits. Established limits could be defined either as pre-determined standards or engineering cost estimates.

Another function of cost control is accurate reporting of current shop costs on active jobs to discover variances from normal. Comparison of final costs against estimated costs not only is a very effective check on ill-planned, inefficient methods, but also is a check on foremen who are not watching their costs. Further, such comparisons build up invaluable statistical data which can be used to develop standards or future estimates.

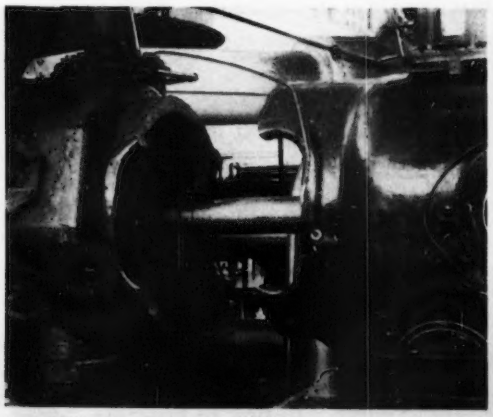
A Cost Control Supervisor was assigned to administer the department and his duties as defined under his job description indicate the scope of his authority.

He was required to supervise the work of receiving, recording and routing work orders for the Mechanical and Electrical departments. He assists the Master Mechanic and Mechanical Superintendent in the development of daily and long range work schedules to provide a basis for calculating manpower requirements. He assists foremen in determining the most effective procedure.

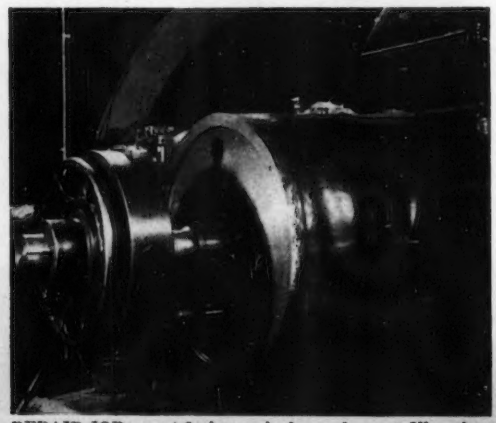
He develops standard costs for maintenance work so that actual performance can be measured against those standards and variances analyzed. He compiles and analyzes cost data as required to prepare the various cost reports requested by the Plant Engineer. He checks labor and material charges against work orders to ensure accuracy of costing. It is his responsibility to calculate incentive earnings of each workman when on incentive. He reports generally on progress of shop programs such as method improvement studies, time studies, etc.

Central dispatching on work orders was first put into effect in September, 1949. After a little over a year's operation, shops' supervision is realizing some of the worthwhile savings that can result and are effectively using the system as a control tool. During the month of September, 1949, 1102 total orders were received by the shops. At the end of that month there were 399 incompleted orders left in the shops. In December, 1950, the total orders received had dropped to 815 and the incompleted orders left in the shops at the end of December had dropped to 210. This is only an indication of a trend but nevertheless significant. There are now far fewer long overdue orders in the shops. Our work load is more systematically controlled and our machine productive time increased. Better scheduling is being done by the foreman and, more important still, top supervision has an intimate and accurate picture of the day to day work passing through the shops.

Here's an Example of How a Well-Equipped Shop Safeguards Production



BROKEN compressor main frame, at C.M.&S. Co. of Canada's plant, was repaired on spot, avoiding much lost time.



REPAIR JOB meant facing main frame for cast filler piece with a facing head on boring bar driven by motor (top).

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WICKWIRE SPENCER STEEL DIVISION, New York, N.Y.

PERSONAL NEWS

James N. Sherwin has been elected a vice-president of the M. A. Hanna Co. A native Clevelander, he joined Hanna's Lake Coal Division upon graduation from Princeton in 1933. He has been vice-president of Hanna Coal & Ore Corporation.

Herman W. Ferguson was appointed State Geologist of Tennessee on May 1 to succeed **H. B. Burwell**, who resigned to enter private business.

GEORGE P. LUTJEN, associate editor with Engineering and Mining Journal since January 1949, has accepted a position as mining engineer with the Division of Raw Materials, Atomic Energy Commission. He will be located in the New York office at 70 Columbus Ave. During his stay with E&MJ, Mr. Lutjen originated and handled the departments, "New Products Digest" and "Behind the Bylines." He also edited the news columns of the magazine, and prepared articles on metallurgical and management aspects of the mining industry. Prior to his employment with E&MJ, Mr. Lutjen worked as a mining engineer for Freeport Sulphur Co. in Louisiana.

L. H. Lange, vice-president and general manager of the metallurgical division of the Galigher Co., Salt Lake City, and consulting metallurgist for Tsumeb Corporation, Southwest Africa, returned to the United States in June after a five-months' trip to various mining properties in South Africa, including Tsumeb.

George W. Wunder, plant manager of National Lead Co.'s MacIntyre Development since 1949, has been named plant manager of the Atomic Energy Commission's new feed materials production center near Cincinnati. National Lead is contract operator of the plant. Production superintendent of the plant will be **David J. Blythe**, who has been superintendent of National Lead's Perth Amboy plant since 1948.

L. E. Hanley, one of the most prominent figures in mining affairs in the Coeur d'Alene area, retired May 27 as president and general manager of Hecla Mining Co. after 47 years with the company. Mr. Hanley will serve as chairman of Hecla's board of directors and chairman of the newly-created executive committee. He began work with Hecla as assayer and bookkeeper in October 1903. He was elected secretary of the company in 1910, and became its general mine superintendent in 1923. On March 18, 1940, he was elected president, succeeding the late James F. McCarthy. Under Hanley's tenure of office the last ton of ore was hoisted from the Hecla mine at Burke in 1944. His efforts have been directed to guiding Hecla's interests in other companies and in opening new orebodies. Through his active leadership, Hecla now has interests in mining operations with such companies as Bunker Hill, Newmont, Polaris, Pend Oreille Mines & Metals, Silver Summit, and others.

A. W. Witherspoon, Spokane attorney and banker and formerly vice-president of Hecla Mining Co., succeeds L. E. Hanley as president and general manager of Hecla and of Polaris Mining Co. **R. E. Sorenson**, Hecla chief geologist, becomes a director and vice-president of Hecla, succeeding Mr. Witherspoon. **R. W. Neyman**, Hecla general superintendent, succeeds Mr. Hanley as general manager of Silver Summit Mining Co.

Charles R. Ince has been made a vice-president of St. Joseph Lead Co., New York, N. Y. Mr. Ince has charge of metal sales. **Rene J. Mechin** has also been made a vice-president of the company. Mr. Mechin served as division manager for St. Joe at Balmat and Edwards in New York from 1926 until 1949.

W. H. Hoover, president of Anaconda Copper Mining Co., gave the principal address June 8 at the 51st commencement exercises of the Montana School of Mines in Butte, Mont. Speaking on copper, Mr. Hoover said that charted reserves of copper in the free world are simply not large enough to supply civilian and military requirements at the same time. He added that the copper industry is prepared to meet any challenge made to it if the United States should again find itself in a fight for survival. **Dr. J. Robert Van Pelt**, president of the School of Mines, conferred an honorary degree of Doctor of Laws on Mr. Hoover, who was presented for the degree by **John W. Bonner**, governor of Montana.

Dwight H. Plackard, of Dallas, Tex., has become executive secretary of the New Mexico Miners & Prospectors Association. Mr. Plackard is a former newspaperman, active in public relations and related fields in the Southwest for the last 15 years. He has been president of the Public Relations Institute of Texas, and is author of the book, *Blueprint For Public Relations* and several articles on the subject. Mr. Plackard replaces **Jack Pierce**, who has been connected with the Assocation for five years. Mr. Pierce becomes assistant editor of *Compressed Air* magazine, Phillipsburg, N. J., on July 15th.

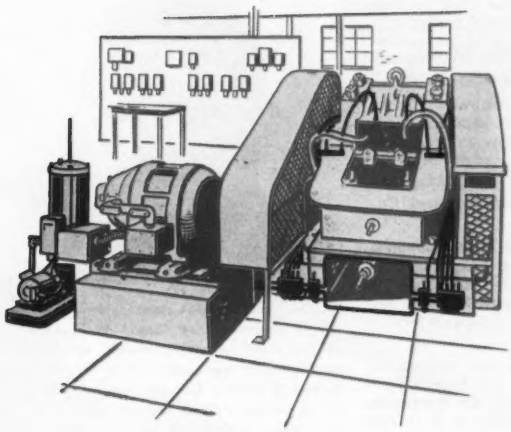
E. Baliol Scott, in June of this year, completed 50 years as editor of *The Mining Journal*, which has the distinction of being the oldest technical journal in the world. Mr. Scott was born in Sydney, N.S.W., in 1873. He came to England in 1886 to complete his education at Bath College and University College, Oxford. In 1901, he became editor of *The Mining Journal*, to which he brought a knowledge of, and an active interest in, mining law. Mr. F. V. **Walters** also completes 50 years of service with *The Mining Journal* this year in his capacity as London advertising representative for the paper.

DR. I. M. LeBARON has been appointed director of research laboratories for International Minerals & Chemical Corporation. His major responsibility will be direction of research programs in the various laboratories of the company. He will report to Dr. Paul D. V. Manning, vice-president in charge of research. A graduate of Syracuse University in 1933, Dr. LeBaron joined I. M. & C. in 1942.

Russel B. Caples has been elected president of the American Zinc Institute, succeeding **E. H. Snyder**, president since 1949. Three vice presidents also elected at the annual meeting were: **Herman D. Carus, Elmer Isern**, and **G. Howard LeFevre. Erle V. Daveler** continues as treasurer, and **Ernest V. Gent**, as executive vice-president and secretary.

R. C. Meyer is now employed in the engineering office of the Copper Queen

Stops bearing trouble on six rock crushers by installing Farval



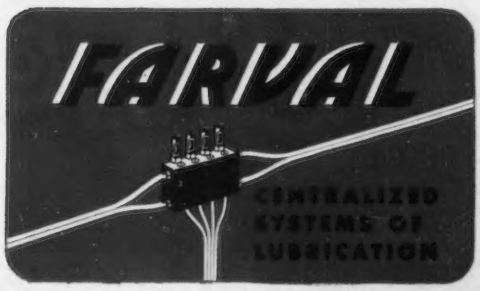
FARVAL—*Studies in Centralized Lubrication No. 104*

FREQUENT bearing failures interfered seriously with production in an ore preparation plant. The material processed was an extremely hard flint-like rock, which not only generated tremendous bearing pressures in the crushers, but created a highly abrasive dust as well. Various methods of lubrication were tried, including drip systems, wick feeds, grease cups, and automatic oil cups. Many of these devices plugged up with dirt. Dust got into bearings and quickly ruined them, resulting in continual shutdowns for bearing replacement.

Finally, a Farval centralized lubrication system was installed on one crusher. It stopped the trouble. It was so successful that Farval systems were installed on the five other crushers. Now the swing jaw, Pitman and main eccentric shaft bearings on each crusher all receive adequate, automatic lubrication. There have been no bearing failures since Farval was installed.

Farval has proven itself in over 20 years of service. It is the original Dualine system of centralized lubrication that others imitate. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports and full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned. For a full description, write for Bulletin No. 25. The Farval Corporation, 3281 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



Branch, Phelps Dodge Corporation, Bisbee, Ariz.

W. C. Hayes has left the State University of Iowa and is now assistant professor of mineralogy and petrology at Texas Technological College, Lubbock, Texas.

H. S. Berube, formerly assistant superintendent for Republic Steel Corporation, Mineville, N. Y., is now assistant manager for East Sullivan Mines Ltd., which operates a 3,000-ton copper property at Val D'or, Quebec.

P. R. Nairn has resigned from the staff of Emperor Gold Mining Co., Fiji, and is now mill superintendent for Raub Australian Gold Mining Co., Ltd., Pahang, Malaya.

Kurt Weinberg has been named vice-president of National Zinc Co., New York, N. Y.

Karl C. Dean is in Mexico to work with **Frank Noe**, chief of mission of the U. S. Bureau of Mines, on metallurgical problems of Mexico's mines under the technical assistance program covered by Point IV.

P. C. Emrath, mining engineer of Marion, Ky., is leaving for Taiwan (Formosa) on an engagement with J. G. White Engineering Corporation of New York. The job will involve examination of both coal and metallic mining properties.

Philip F. McKinley has been recalled to active duty with the U. S. Air Force. He is photomapping officer at Barksdale AFB, La.

E. L. Bemis has resigned his position as superintendent of the Canisteo mine of Cleveland-Cliffs Iron Co. owing to ill health, and is moving to Florida. **Jack Chisholm**, formerly assistant superintendent, is acting superintendent.

Giulio Giuliani, formerly in charge of truck maintenance, is now acting superintendent of the Wanless and Atkins mines of the Cleveland-Cliffs Iron Co., following the resignation of **Roland Erickson**.

Guy Riddell returned recently to his offices at Royal Oak, Md., and Washington, D. C., after making lode and placer examinations in Nevada, Arizona, and California. He had completed in March a six-month assignment for the Bureau of Mines on one of the strategic metals now in short supply. His headquarters is with Charles H. Upham & Associates, 606 Cafritz Bldg., Washington, D. C.

Lancelot Balderson has been appointed assistant to the vice-president in charge of iron ore operations of Oglebay, Norton & Co., Cleveland, Ohio.

Alfred Scheidecker has been appointed traffic manager of the Duluth, Missabe and Iron Range Railway, succeeding the late J. L. Abramson. **G. C. Carlson** has been appointed assistant traffic manager.

John Evans, Phoenix, Ariz., is the new president of Comstock Extension Mining Corporation, which is working zinc-copper properties between Globe and Miami, Ariz.

Victor Lager, shop foreman at the Harrison shop in Cooley, Minn., has been promoted to master mechanic for the Cooley District of M. A. Hanna Co.

W. F. Betzler, of the Inter-State Iron Co. engineering force, has been appointed engineer at the Longyear mine to succeed **Julius Strande**, who has been transferred to the general office in Virginia, Minn.

Arthur E. Kivisto, mine mechanic of Deerwood, Minn., has been awarded a Joseph E. Holmes metal for heroism in saving the life of a fellow worker, **Edwin A. Antilla**, whose clothing had been set afire by a gas explosion.

Rodney D. Hodge, Ironwood, Mich., has been promoted to superintendent of the Pickands Mather & Co.'s Sunday Lake mine at Wakefield, Mich.

Wayne Ahl is now engineer at the Sherwood mine of Inland Steel Co., Iron River, Mich.

Clifford Wendel has left the geological department of Anaconda Copper Mining Co., Butte, Mont., and is now chief geologist with Patino Mines & Enterprises, with headquarters in Llallagua, Bolivia.

David H. Miller is now engaged in fluorspar mining in the Illinois-Kentucky field for one of the companies there. He can be reached at P. O. Box 176, Rosiclare, Ill.

Lawrence B. Wright has returned to San Francisco from Baja, California, where he has been engaged for several months in mineral resource study for the Territorial Government. Area of the investigation lies south of the 28th parallel to the tip of the peninsula. Further work is being done on a vein of copper-cobalt ore and a vein of silver-gold-lead ore.

Dr. P. T. Carter, leeturer at the Royal Technical College, Glasgow, Scotland, is visiting metallurgical and mining centers in the United States and Canada. He has been awarded a Nuffield Foundation Traveling Fellowship for 1951 in extractive metallurgy.

J. R. Woodul, vice-president of the American Smelting & Refining Co., retired from active duty on June 1, 1951, but will remain as a consultant to the company on Latin American affairs.

K. C. Brownell, president of the American Smelting & Refining Co., returned recently from visiting the company's Mexican and Southwestern smelters. He was accompanied as far as Corpus Christi, Texas, by **S. H. Levison**, vice-president, and throughout the entire trip by **J. D. MacKenzie**, vice-president, and **R. P. Reese, Jr.**, assistant to the president.

OBITUARIES

George S. Rice, retired chief mining engineer of the U. S. Bureau of Mines, died in Takoma Park, Md.

Raymond E. Tower, mining and metallurgical engineer, died in Salt Lake City, May 18. At the time of his death, Mr. Tower was vice-president and general manager of Sarita Milling Co., Salt Lake City. Born in Missoula, Mont., in 1889, Mr. Tower graduated from the Montana School of Mines. He was widely known as a consultant in Western mining operations.

JAMES L. LEONARD, prominent Spokane mining engineer, died May 5 in Spokane as the result of an automobile accident. Mr. Leonard was president of Metaline Mining & Leasing Co. and was a director of Grandview Mines. He was active for many years in mining affairs in the Metaline Falls area and in the Wallace-Kellogg area. He was born in Spokane and graduated from Gonzaga High School. He was past president of the Northwest Mining Association, the Spokane Section of the A.I.M.E., and the Spokane Association of Engineers.

Donald Steel, consulting mining engineer and geologist, died in Palo Alto, Calif., on January 10. Mr. Steel was noted for exploration for gold and diamonds in the Belgian Congo and Angola. Educated at Stanford, he was advisor for Metals Reserve Co. from 1942 to 1945, and had completed numerous mine examinations in the U. S. and throughout the world.

Macy Nicholson, 75 years old, president of the Crystal Fluorspar Co., died May 29 at his home in Hagerstown, Ind., after several years' illness. Mr. Nicholson was formerly general manager of the Great Northern Railroad, and had been associated with the Milwaukee Road as well. He served for a time as head of the National Railway Labor Adjustment Board.

Edward L. Clair, president of Interlake Iron Corporation, Cleveland, Ohio, died June 13. He started with the firm in Toledo, Ohio, 1920, in the blast furnace department and became president in 1949.

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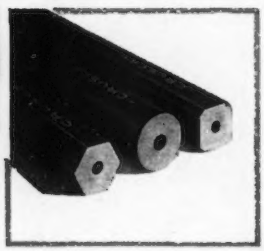

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PREVIEW

Dustless Drill Requires No Water

Dust is removed from cutting face through ports in carbide bit on hollow drill steel.

Tube through machine is slightly larger than that in conventional machines using water.

DUSTLESS DRILLING without water is the feature of the new rock drill just placed on the market by Holman Bros., Ltd., Camborne, Cornwall. Besides being a definite contribution to the constant struggle against silicosis, the new drill, trade named "Dryductor," offers several other advantages.

Sampling can be made automatic by having the machine discharge dust into a collector at any convenient point in the mine.

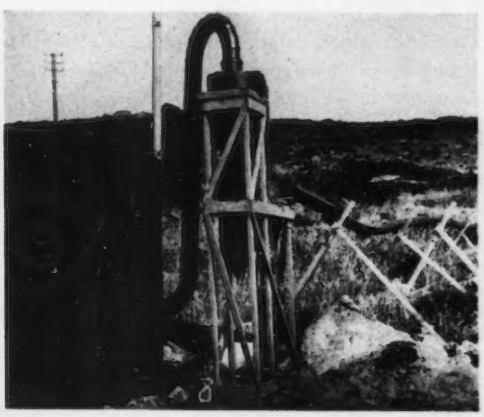
The entire dust ejecting system is under a vacuum. If for some reason the vacuum is cut off, the machine will not operate, insuring safe operation as far as dust hazard is concerned.

By removing dust from the hole as soon as it is made, the drilling speed of the machine is increased because clear face is presented at each blow of the machine.

Dust from drilling operation can be collected and disposed of as far as 1,000 ft. from the machine by using a conduit and fan.

For further information circle No. 1 on stamped, addressed postcard opposite p. 174 and mail.

Hose discharges dust into conduit. Sampling can conveniently be done at this point.



Cyclone and fan, as far as 1,000 ft. from drill, keep system under vacuum, collect harmful dusts.

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The moving breaker plate carries the feed into the path of the hammers, making it impossible for sticky feeds to build up on the breaker plate out of reach of the hammers.

Shortly after the purchase of the Dixie Machinery Manufacturing Company, each and every part of the famous Dixie Non-Clog was carefully checked as to design, materials and construction. Performance records, and replacement parts for thirty years back were dug into, studied and considered. Then improvements were made to conform with Pennsylvania standards. Always an outstanding mill, today the Dixie Non-Clog is a stronger, more serviceable machine in a number of ways.

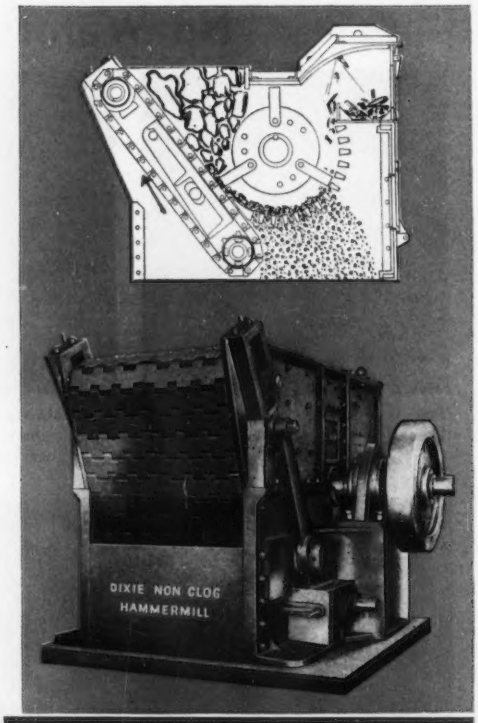
The Frames are being redesigned, using heavy welded steel plates instead of castings.

The Hammers have been redesigned to strengthen the eye and are now made of special alloy steel or manganese.

The Shaft is now a forging of special alloy steel—it has been redesigned, heavier and stronger to eliminate breakages.

Bearing housings have been improved.

Liners have been redesigned to give protection where needed to prolong the life of parts.



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CRUSHERS

For Your Files

This informative manufacturers' literature is free unless otherwise specified. To obtain bulletins circle their numbers on card below and mail.

MECHANICAL PACKINGS. Compiled in an easy-to-read style, this 32-page booklet graphically illustrates and describes Flexrock mechanical packings. Includes a simplified recommendation chart. Flexrock Co., Philadelphia 4, Pa. (71)

OIL FILTERS. "Don't Buy Trochle" is a 16-page informative booklet dealing with oil filters, their purpose; their make-up, and the qualities to be looked for in a filter. Caterpillar Tractor Co., Peoria, Ill. (72)

LUBRICATION. "Lubriplate, the modern lubricant" offers you a booklet full of recommendations for its use whether you're in a ladies' underwear factory or the mining industry. Fiske Brothers Refining Co., Newark, N. J. (73)

PNEUMATIC CONVEYOR. Features and applications of the Flo-Veyor system, which first air-activates and fluidizes bulk materials and then transports the aerated mixture under air pressure, are discussed in this bulletin from Brady Conveyors Corp., Chicago, Ill. (74)

POWER TRANSMISSION. Here's a bulletin that illustrates, describes and tells you why the manufacturer calls this chain drive revolutionary, combining as it does the ruggedness and dependability of gear drive with the smoothness of a belt. Morse Chain Co., Detroit, Mich., calls it the Hy-Vo drive. (75)

CATERPILLAR PRODUCTS. This yearly booklet, 40 pages this time, has a complete listing with pictures and brief specifications of 81 Caterpillar products. Caterpillar Tractor Co., Peoria, Ill. (77)

SAND FILTER-CLARIFIER. Not a back-wash filter; this unit uses a spiral scraper that takes a cut off the sand bed when the filter rate decreases. Read all about it in the 4-page bulletin No. 30-B, published by Hardinge Co., York, Pa. (78)

LODOVER SHOVEL. Eight pages of illustrated how and why this 1-yd. combination overhead and front-end shovel for International T-9 and TD-9 tractors, can save you money, are offered by Service Supply Corp., Philadelphia, Pa. (79)

RECORDING METERS. Features of the Series 500 recording voltmeters and ammeters, with special emphasis on the newly-developed moving-iron measuring mechanism, are described in a 28-page bulletin, No. B1111, issued by Bristol Co., Waterbury, Conn. (80)

INDUSTRIAL LIGHTING. Aimed at the industrial plant operator, this 16-page booklet stresses 3 ways that better light can work for him: (1) cut costs by making increased production possible; (2) increase efficiency by ensuring accuracy; (3) reduce accidents by clearing exposing dangers. Westinghouse Electric Corp., Pittsburgh, Pa. (81)

BELTING. An informative 16-page booklet on belting, which includes practical maintenance suggestions and engineering data, has been released by E. F. Houghton Co., Philadelphia, Pa. Title is "Houghton's Traded Leather Belting." (82)

BISMUTH WIRE. You should find this booklet on ductile bismuth wire interesting. Although bismuth wire must be handled carefully, it makes some unique electrical properties available to engineers. Fitzpatrick Electric Supply Co., Muskegon, Mich. (83)

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3. What did you think of the issue as a whole?

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Equipment Shorts

WELDING ELECTRODE. A 25% faster deposition rate is the claim made by the manufacturer for a new hard surfacing electrode. Rankin Mfg. Co., Los Angeles, Calif. (31)

PUMPS. Re-design of their line of high head pumps has been announced by Economy Pumps Inc., Hamilton, Ohio. Compactness, efficiency and mechanical ruggedness have been improved. Pumps have capacities up to 4,000 gpm. against heads up to 750 ft. (32)

TELEPHONE AMPLIFIER. Unit permits several persons to participate in all telephone calls, local and trunk. Works on any phone. Heinz A. Eisert, Hanover, Germany. (33)

SELF-ALIGNING IDLER. On the theory that most damage to conveyor belts from roving occurs at the edges, on the return run where it is out of sight, Chain Belt Co., Milwaukee, Wis., offers an improved type of self aligning return idler to combat this type of wear. (34)

DREDGE BUCKET PINS. A Malayan dredge will be equipped with sealed and lubricated bucket pins of its own design. Experiments revealed that wear in these pins is about 1/64 in. in 9 months as compared to ¾ in. in conventional pins over the same period. Lubricant is applied by grease gun through non-return ball valves at either end of the pin. Makers are Southern Malayan Tin Dredging Co., Batu Gajah, Perak. (35)

PROTECTIVE COATINGS. To patch rubber linings and coatings mechanically damaged in corrosion service, Carboline Co., St. Louis, Mo., has developed Carbo-Flex 6040. It bonds well with rubber shrinkage of only 0.1%. Corrosion resistance and flexibility are equal to rubber and it is easily mixed and hardens at room temperature. (36)

MECHANICAL SEAL. A Teflon wedge ring enables this new seal to combine the chemically inert properties of Teflon with the flexibility and positive sealing needed in effective mechanical sealing. Type 9 seal has been developed by Crane Packing Co., Chicago, Ill., for use on rotating shafts in centrifugal pumps, agitators, turbines, etc. (37)

MAP STICK. For convenience around the surveying office a new plastic map stick has been developed to simplify mounting of maps, tracings, drawings and blueprints. Sheets snap on sticks without use of tools, nails or glue. Ross-Martin Co., Tulsa, Okla. (38)

TACHOMETER. Simple rotation of indicator range knob instantly selects one of 3 speed ranges to measure any speed over a range of 40 or 50 to 1; with various tachometer heads you can check speeds between ½ and 100,000 rpm. The indicator can be located up to 1,000 ft. from unit being measured, without affecting calibration. Metron Instrument Co., Denver Colo. (39)

AIR VIBRATORS. To keep your bins, hoppers, chutes or what-have-you from clogging, Cleveland Vibrator Co., Cleveland, O., offers its type "F" unit whose simplified design has reduced to 5 the number of major parts. This should make for easier maintenance and less wear. (40)

CLEANING SOLVENT. Guaranteed solvent cleaner for all metals is Cyclodiene, a liquid hydrocarbon. It is used at room temperature and has no rusting effect on iron or steel. Dissolves grease, oils, buffing compounds and other dirt from metal surfaces, but is not toxic. You can get a free sample by writing on your company letterhead to Colonial Alloys Co., Philadelphia 29, Pa. (41)

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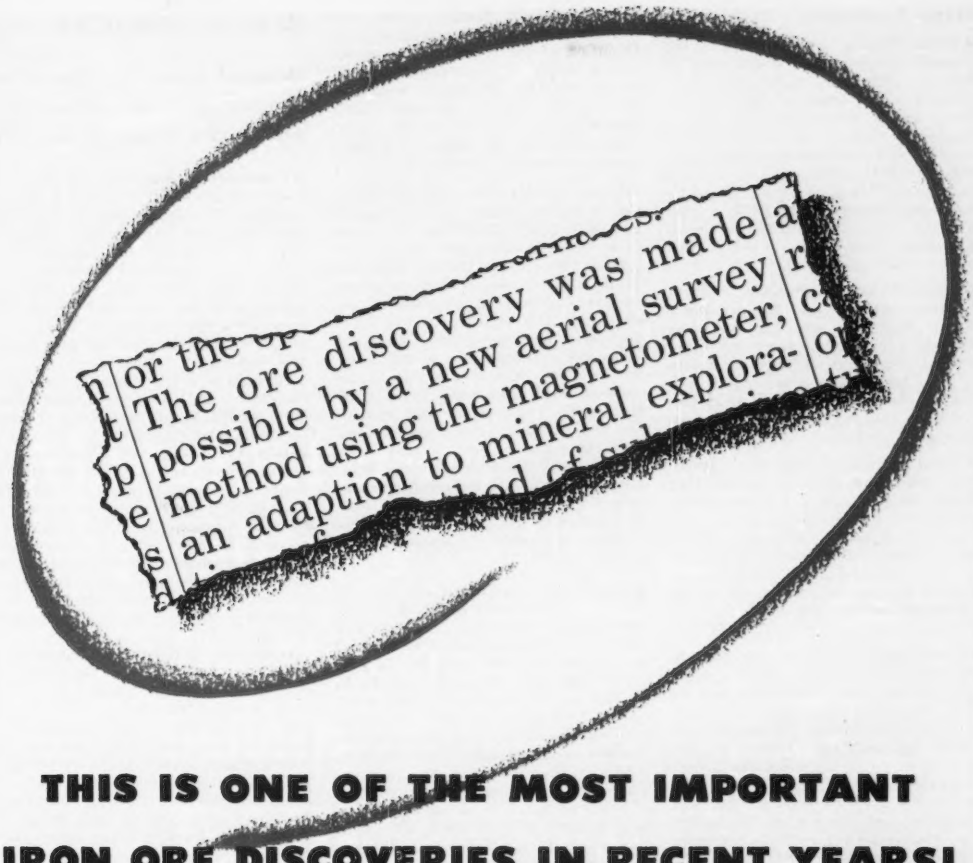
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Idaho *(Continued)*

★**Hecla Mining Co.** prospected the Sunshine mineral zone about 5,000 ft. further east by sinking the Silver Summit shaft down to the 3,000-ft. level, where a crosscut revealed a heretofore unknown structure of commercial size containing exceptionally high values in silver and a by-product of copper. This orebody has been developed on down to the 3,400-ft. level. Another crosscut opened similar ore in a parallel vein in the Chester and Silver Dollar properties.

★**Coeur d'Alene Mines Corp.**, a short distance east of the Hecla-Polaris-Silver Summit operation, has just recently discovered in American Silver ground at a depth of 2,800 ft. a vein of very high grade silver-copper ore, but not enough development work has yet been done to determine its commercial importance.

★These discoveries encouraged **American Smelting & Refining Co.** and **Day Mines, Inc.**, to sink a 4-compartment shaft to the 3,000-ft. level on the same mineral belt about 18,000 ft. east of Silver Summit at a cost exceeding $1 million, resulting in the discovery of at least 3 silver-lead veins, which the companies are now preparing for production.

★Hecla was encouraged to explore the same belt at depth about 7 miles still farther east. With this end in view, Hecla has organized a new company in which **Hecla, Newmont, New Jersey Zinc**, and **Atlas Mining Co.** are equal owners, to sink the Atlas 3-compartment shaft at Mullan from the 800 to the 2,400-ft. level as the first objective, and deeper if necessary. The ground owned by this company is around two miles wide and eight miles long, extending from half way between Mullan and Wallace east to near the Montana state line.

★**The 3,000-ft. depth idea** also applies to the older mines of the district which, with the exception of Bunker Hill and Page mines, are located on the north side of the Osburn fault. **Tamarack** and **Dayrock** have already sunk to lower levels, and other mines in this area are preparing to do so.

★**Day Mines** has now unwatered the old Hercules mine at Burke, where an exceptionally large and rich ore-shoot was cut off by a fault on the 1,000-ft. level. Pending further sinking, the company did some prospecting further west on the 1,000-ft. level and discovered an important vein of silver-lead ore which is now in production. Day Mines has also purchased the Hunter mine at Mullan, where ore production stopped on the 1,100-ft. level. The Day company is reported preparing to sink a new shaft to prospect the vein system, which has been productive since 1884. The Hunter lower tunnel is in a distance of one mile and is strategically located for deep development of the King group, some 10,000 ft. further north, also owned by the Day corporation. Continuation of the Hunter tunnel would give a depth of approximately 3,000 ft. on the King property, which consists of a group of patented claims extending from Burke to the Snowstorm mine east of Mullan, a distance of approximately eight miles.

★**Lucky Friday Silver-Lead Mining Co.**, a locally owned stock company, has developed a producing silver-lead mine at Mullan in a new mineral belt located between the Osburn fault and White Ledge dyke, heretofore unproductive territory. The company has developed the ore zone with funds derived from development ore sales from the surface down to the 1,800-ft. level. It is now sinking to the 2,000-ft. level, from which point it will thoroughly prospect the vein system. On the 1,800-ft. level development work shows two rich parallel veins, one about 8 ft. wide and the other about 3 ft., the latter showing average values of 41 oz. silver and 40% lead. The company has just paid an initial dividend of 5 cents per share, amounting to $64,574.

★In the western end of the district, **Bunker Hill & Sullivan M. & C. Co.** has been in continuous operation and production for a period of 63 yr. and at the present time has the largest silver-lead and zinc ore reserves in its history. In doing development work on the 2,200-ft. level in 1942 the company discovered what is known as the Truman vein, which J. B. Haffner, manager, describes as a major silver-lead orebody, containing an average of 8% lead and 5 oz. of silver per ton over a width of 12 to 15 ft. This vein has since been explored on higher and lower levels, showing a length in excess of 600 ft. This is in addition to large orebodies in other parts of the mine.

During recent years the company has started a block caving system in an upper section of the mine near the old town of Wardner, where early operations left low grade ores in large blocks of ground and which present mineral prices and mechanized production methods make profitable on a large tonnage basis. In regard to this system, which is probably the only one of its kind in the Northwest on lead ore, Mr. Haffner says:

"As far as our block caving is concerned, it was resumed last December, when weather conditions interfered with reclaiming old jig tailings. At the present time, the production from the block caving amounts to approximately 1,200 tons per day which, together with our regular mine production from the square set stopes and a certain amount of old jig tailings, provides full operation of the concentrator. As the jig tailings are nearing exhaustion, increased production will be made from the block caving operations up to a final capacity of approximately 2,000 tons per day."

ILLINOIS-KENTUCKY

Demand surge has miners on run for more ore—Rosiclare area nears peak production

★**Fluorspar producers** in the Illinois-Kentucky district are facing a major question in the production-for-defense effort: where is this increased production, so insistently demanded by industry, to be obtained? Operators will try to find the answer in further development work, re-opening of old properties, expansion of facilities, exploratory diamond drilling programs, and capacity operation.

Already industry is calling for large increases, and it is estimated that from 40,000 to 50,000 additional tons of acid fluorspar will be required within the next year. Furthermore, recent announcement of the Munitions Board's proposal to stockpile 200,000 tons of acid spar, which is equal to 1.6 yr.'s consumption at the 1950 rate, as well as stockpiling metallurgical grade, represents an additional demand which producers must meet. In terms of tonnage production, the Illinois-Kentucky region is the principal source.

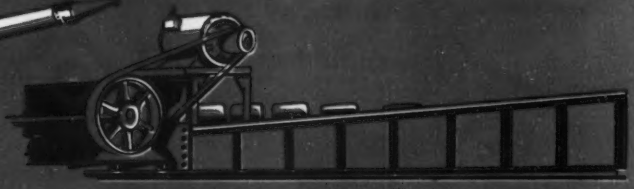
Operators believe that additional quantities required for Government stockpiling and for increased industrial demand can become available only through some combination of new deposits, new plant facilities, and a substantially higher price structure. Such a program would tend to increase production through enabling high-cost producers to operate at a profit, or at least to break even, and through bringing into production areas which have been held back from development by prohibitive cost.

Effort of operators to increase production of fluorspar, which is essential in the nation's peace-time and defense-geared economy, is entirely on a voluntary basis since no government directives, or request for larger production, have been received by any company. **There has been no information sent operators on proposed stockpiling. The industry is going ahead on its own initiative and exercising its own best judgment.**

Diamond drilling programs, new development, and improved facilities are planned in several quarters with a view to increasing production. Exploration has discovered what is believed to be an entirely new fault in the Illinois district.

★**Ozark-Mahoning Co.**, of Rosiclare, Ill., is operating at capacity and has not been able to supply the demand of its acid spar customers, who have been placed on an allocation basis. All customers are asking increased allotments. The company recently has taken options on properties in Colorado and New Mexico in an effort to develop additional ore.

Climax Hydraulic Guns



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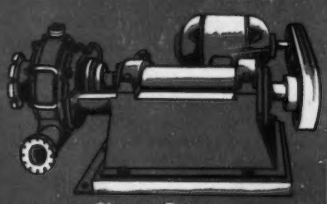

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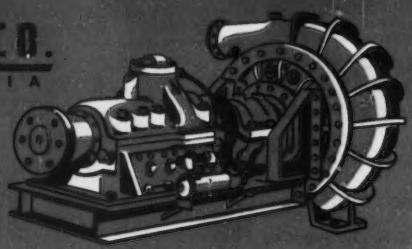
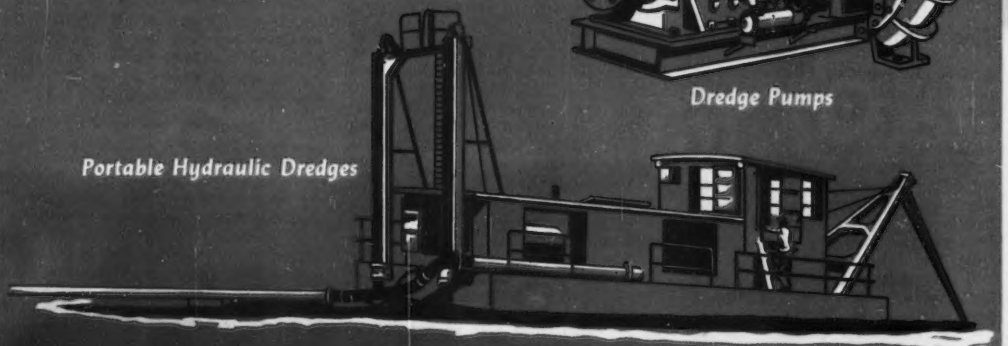


Dredge Pumps



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Illinois-Kentucky *(Continued)*

★**Alcoa Mining Co., Fluorspar Division,** of Rosiclare, is planning expansion of its mining program over a period of the next few months by reopening three mines, two in Kentucky and one in the Illinois field. The old Silver mine, also known as the Royal, in Livingston county, Ky., near Smithland, will be reopened in the fall; and the Klondike mine, acquired from the Salem Fluorspar Co. several years ago, will be reopened about the first of next year. It will be powered by a new line to be installed by the Kentucky Utilities Co. Reopening of the Hamp mine, located in Hardin County, Ill., 15 miles northeast of Rosiclare, which has been shut down since 1942, will take place immediately. A contract already has been signed with REA for power supply. Alcoa will double its power plant capacity at Rosiclare in an installation project already under way. Foundation for one new compressor is in, and excavation for the foundation of another compressor and a turbine generator has been started. Fulfillment of power demands will come on gradually over a period of months. Pumping will represent the heaviest power demand. Cross-cutting from the Fairview shaft on the Blue Diggings vein, to the Good Hope vein on the 500-ft. and the 700-ft. level, has been started with a total of 2,000 ft. to be driven.

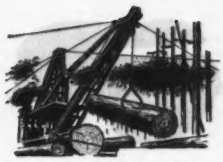
★**Rosicale Lead and Fluorspar Mining Co.,** producing ceramic and metallurgical spar, expects to increase production from its Pigmy property in the Kentucky district this year. Floods last year interfered with operations. The Rosiclare plant is operating at capacity and will continue to do so through this year.

★**Minerva Oil Co.'s** mining and milling operation north of Cave-in-Rock increased its tonnage treated to a new high of 75,000 tons in 1950. It now holds the position of the leading producer of ceramic grade fluorspar. Recently the company introduced diesels into its mining scheme, the bedded replacement ores being well adapted to the use of diesel shovel loaders and diesel dump trucks. In the mill, six additional cells have been added to the fluorspar flotation section. An additional ball mill is planned in the near future to be added to the secondary grinding circuit.

★**Crystal Fluorspar Co.** is at its highest peak of production since mining began in the Cave-in-Rock section of Hardin County 21 years ago. Production in April and May averaged 2,500 tons per month; and the June and July production schedule calls for 3,000 finished tons per month, which makes the Crystal, for that period, the largest producer of metallurgical-grade fluorspar in the industry. This acceleration in production results from installation of a Wemco Heavy Media Separation plant. To increase production, 2 Richards jigs, one Bendelari jig, and 4 Deister-Overstrom tables have been added to the flow sheet of Crystal's new mill to facilitate concentration of ore from their Jefferson mine. This addition is for removal of lead and zinc sulphides from the Jefferson ore. Prior to this additional facility, the Jefferson's lead-zinc-fluorspar ore had to be run through the HMS mill twice for separation of the sulphides from the fluorspar concentrates.

★**Grand Pierre Mining Corp.,** which started production only last September, after sinking a 318-ft. shaft and installing a jig mill on its property in the eastern section of Pope county, Ill., is mining and milling fluorspar-lead-zinc ore from its Grand Pierre mine, and expects to continue at capacity operation. Grand Pierre is on an extension of the old Empire fault.

★**ABC Fluorspar Mining Co.,** whose operation is closely affiliated with the Grand Pierre operation, at present is diamond drilling on property south of the Grand Pierre mine and believes that they are on an entirely new fault, distinct from the old Empire fault. Drilling was started a few weeks ago and will be continued. The property adjoins Grand Pierre mine. The same operators also are mining crude ore at Spar Mountain mine, the old Benzon property in the Cave-in-Rock district, for sale to Kentucky mills.



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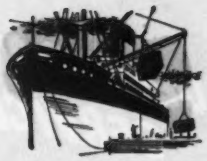
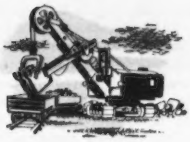
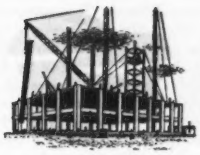


For Marine



For Stone Quarries



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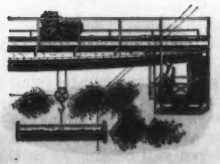

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Illinois-Kentucky *(Continued)*

★**Victory Flourspar Co.**, operating in the Cave-in-Rock district, recently leased 140 acres west of Grand Pierre mine. Exploratory work has been under way the last few months, and a diamond drilling program will be continued. Victory resumed operation May 1 after being shut down since last November. Capacity operation will be continued in the coming months.

★**Hicks Creek Fluorspar Corp.**, mining on the old Empire fault in eastern Pope county, plans construction of a new 200-ft. shaft and anticipates good production. Work will be started as soon as the necessary equipment can be obtained, which probably will be early fall. Hicks Creek's present operation is on the Douglas property in Pope county, from its No. 1 shaft, working on a 6-day-weekly schedule.

★**PMT Fluorspar Corp.** is mining on Douglas property in Pope county, leased from Hicks Creek Corp., and is working at capacity with two shifts per day on a 6- and sometimes 7-day week. Production will continue at an estimated 1,000 tons per month.

★**U. S. Steel**, a major fluorspar producer in the Kentucky district, started exploratory work in June on the company's Big Four property at Sheridan, in Crittenden county, with a view to increasing production. An extensive diamond drilling program is planned to be continued over a period of the next few months. The Big Four property has been held inactive by U. S. Steel for several years, pending exploration and anticipated development.

MICHIGAN

C. & H. seeks defense jobs—Hanna needs help with mines, plans big iron ore projects

★**Calumet & Hecla Consolidated's** first defense contract for the present emergency was undertaken through its Wolverine Tube division in August of 1950. Defense production contracts will be further increased by the considerably expanded number of pilot projects undertaken during the second half of last year. These projects are largely of a secret or confidential nature.

The Government likely will be the company's largest customer in the immediate years ahead, according to President E. R. Lovell. These orders will require the manufacture of entirely new products.

Particular emphasis has been put on application to the needs of the various Government agencies concerned with defense. Various projects on a pilot or experimental basis were in progress for the Government at the close of 1950. This is a continuation of similar work initiated during World War II, when the Wolverine Tube division took leadership in standardizing production of rotating band blanks for projectiles, originated the production process (now standard) for Army and Navy primers, and pioneered extrusion of plutonium tubes for the Manhattan Engineer District, now the Atomic Energy Commission. Continuation of this Government development work through the post-war years put the company in a favorable position to supply defense needs.

In Calumet & Hecla's mining division some of the company's mines, shut down and flooded during depression days, could be rehabilitated to produce much-needed copper if adequate Government incentives become available. Accelerated exploration for additional deposits of both copper and zinc are in progress, according to President Lovell. The company owns more than 200,000 acres of copper bearing lands in Northern Michigan. Recent study of this area by the U. S. Geological Survery indicates the region is one of the most promising copper mining districts in North America. Mechanized equipment is being used in Northern Michigan for removing overburden and uncovering bedrock. This relatively new method is believed to be more effective than the older method of diamond drilling. Churn drilling is being used in the Wisconsin area to extend and outline the several orebodies under development, and to explore the block of land under lease. The results have been encouraging.

★To meet the heavy demands for electric power at Michigan mines, **Wisconsin-Michigan Power Co. is building** three hydro-electric power plants at Iron River, adding to sub-station capacity at Crystal Falls and building a new power line to the new Cayia mine east of Crystal Falls.

★**The Bradley open pit and the Globe-Cornell pit**, both at Iron Mountain and both silicious iron ore properties, are the only iron ore properties now operating in Dickinson county, where once some of northern Michigan's busiest mines were located. Both of these mines are now shipping and adding their bit to the heavy movement of ore down the Great Lakes.

★S. E. Quayle, general superintendent of **M. A. Hanna Co.'s** Michigan operations, has announced that the company will construct a pilot plant for the beneficiation of low-grade iron ore. It will be located 3 miles east of Randville, near the Groveland mine location, and will be the first plant of its kind in the upper peninsula. Although the plant will be small and experimental, it may eventually mean much to the large tonnages of low grade ore in Michigan. The process employed will be similar to that used on taconite with modifications to fit the ore involved.

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Michigan *(Continued)*

★**M. A. Hanna Co.** has built a screening and crushing plant at its Wakefield mine at Wakefield which has been idle for some years. The plant will handle the large stockpiles of low grade ore which were built up during the Wakefield's active shipping years. A belt conveyor carries the ore from the new plant to the old shaft house pocket for loading into railroad cars. Trial shipments have already begun at the rate of 750 tons per day which will be mixed with ore from Hanna mines in the Iron River district.

★**Pickands, Mather & Co.'s** Zimmerman mine at Gaastra is again producing after having been idle for two years. General superintendent, Harold J. Richards, of the P. M. & Co. mines in the Iron River district, reports that 92 men are now employed at the Zimmerman.

★**The State of Michigan** has acquired an interest in the Wauseca mine through non-payment of taxes. The mine yielded 3186 tons in the first quarter of 1951 and the State will receive the first royalty payment ever paid by an iron mining company for ore taken from state owned and leased land, the Conservation Department's Land Division has announced.

★Several **M. A. Hanna Co.** underground mines in the Iron River district pre-heat their ventilating air before it is blown into the mine to prevent icing of air shafts and the intermittent freezing and thawing in shafts which tends to loosen the rock walls. The heating plants are of two types, steam heat and hot air, coal being used as fuel in both types.

★**Pickands, Mather & Co.** has transferred the Gogebic range laboratory and grading department from the Anvil mine to Verona, where new and larger quarters have been provided. The Cary, Newport, Plymouth, Sunday Lake, Eureka and Ironton mines are served.

★**Jalore Mining Co.**, which is a subsidiary of the Jones & Laughlin Steel Corp., is diamond drilling on the Michipicoten iron range of Ontario.

★At **Inland Steel Co.'s** Bristol mine, Crystal Falls, a 1,400-ft., 36-in. wide belt conveyor is being installed on the twelfth level to bring ore from the mine workings to the hoisting shaft. The Bristol was dewatered in 1948 and 1949 and shipped 105,017 tons in 1950. At Inland's Cayia mine, near Crystal Falls, a timber headframe is being erected and shaft sinking will begin soon.

★For the week ended May 21, shipments of iron ore from upper lake ports amounted to 2,931,154 tons. Season shipments on that date were 14,354,631 tons. Comparable figures for 1950 were: 2,402,524 tons and 5,865,426 tons, indicating a week by week gain over last year.

MINNESOTA

Oliver develops pits—Spirals for Interstate—Reserve buys power for Babbitt plant

★In its group of mines of the Chisholm area, **Oliver Iron Mining Co.** is developing open pit ore that will go far toward replacing the part taken by the old Hull-Rust-Sellers group of the Hibbing district in World Wars I and II. The Chisholm group, which includes the Sherman, Fraser, Hartley, Forster, Humphrey, Alworth and St. Clair, though it has not attained its maximum production, is already supplying about 700,000 tons of ore per month. Much of the ore from the group is run through the new screening plant at the Sherman mine, where it is separated into fine and coarse products in line with present day furnace requirements. Plans are under way for the construction of another unit at the Sherman plant which will duplicate the modern and efficient one now in use. This plant handled its first ore in August of 1950.

In addition to the Sherman group, **the Monroe pit** near Chisholm is rapidly being developed to the big production of which it is capable. Its present output is about 450,000 tons of ore per month. Added to that of the Sherman group, this makes a total of some 1¼ million tons per month. The Hull-Rust-Sellers group in World War II forwarded a record shipment of more than 20 million tons of ore in one year, or nearly 3 million tons per month for the shipping season.

While the Chisholm group of mines covers a larger and more scattered area than the remarkable Hull-Rust deposit, it will be seen that Oliver's Hibbing-Chisholm district is prepared to continue its vital contribution to the country's steel plants if a third world war should again call on the Mesabi range for its utmost production.

★The Judson mine near Buhl, with about 257,000 tons of ore available, is being stripped by **W. S. Moore Co.** of Duluth. Total stripping required will be approximately 450,000 cu. yd. The Judson is a Minnesota state lease.

★**Revised figures for 1950 shipments** from the Lake Superior district show 82,186,545 tons of ore against 70,991,490 tons in 1949. The trend of beneficiated ore (mostly by washing) continued upward with 25.45% for the entire district and 30.42% for Minnesota shipments. With the demand for iron ore increasing due to defense preparation, and the proportion of merchantable ore in reserve declining, it seems probable that the percentage of beneficiated ore will continue to climb.

★**A battery of fifty Humphreys spirals** has been installed at Inter-State

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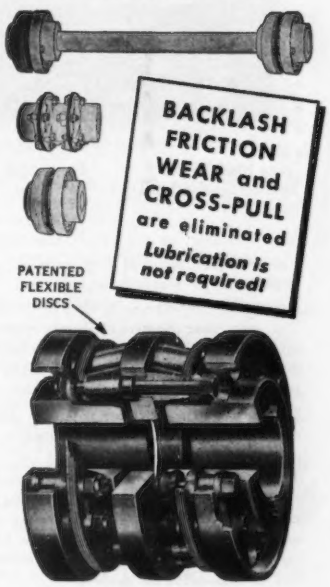

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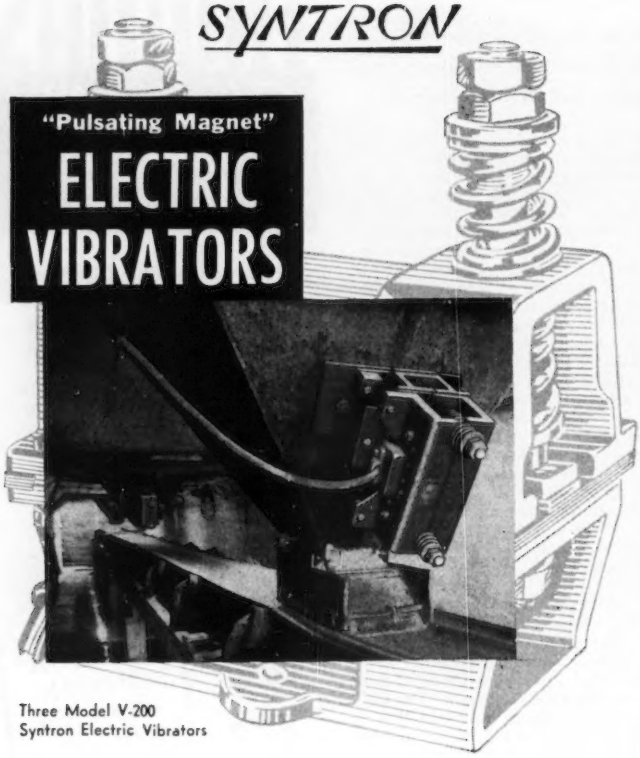

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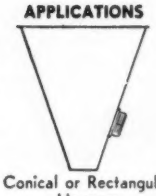

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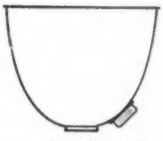

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Minnesota *(Continued)*

Iron Co.'s Grant mine at Buhl to treat the approximately 300,000 tons of tailings that has accumulated since 1945. It is expected that about 70,000 tons of concentrates can be recovered. The plant building was erected during the winter months and equipment installed in time to begin operation this spring.

★**April shipments of iron ore** from upper lake ports were 6,211,474 tons, or nearly 6 million tons more than 1949's 348,804 tons, due to last year's late opening. This seems to promise a large total shipment for a year when, perhaps, ore was never more needed.

★**M. A. Hanna Co.** has moved its Duluth office to the company's main office in Cleveland. Russell C. Fish, general manager, has transferred his headquarters there and R. W. Whitney, general manager of Minnesota mines, will now handle matters concerning this area that formerly went to the Duluth office. The Hanna company's vessel department will remain in the Fidelity Building in Duluth.

★**The M. A. Hanna Co.** is continuing the work of stripping the Morton property, near Hibbing, with its 25-cu. yd. Bucyrus-Erie dragline, portable screening plant and spoil-disposal conveyor system.

★**Reserve Mining Co.** has contracted for 7,500 hp. of electric power for its pilot plant near Babbitt which is now under construction. It will have an annual capacity of 300,000 tons of taconite concentrates. The Minnesota Power & Light Co. will build a new high voltage transmission line to serve the plant.

★**West Indies Mining Co.** has been organized by Iron Range and Duluth men to operate an iron ore property in Puerto Rico. Officers are: E. A. Young, of Hibbing, Robert Crasweller, Duluth, and James Hustad, Duluth, who will be in charge of the operation. The property is estimated to contain 3 million tons of ore and samples have shown it to run 60% natural iron, 4% silica, and low in phosphorus. The mine will be operated by the open pit method and the lease provides that a certain quantity of ore must be loaded in 1951. The ore will be shipped to the **Barium Steel Co.** of New York after being hauled about 30 miles to the port of San Juan to ocean carriers.

★**Two new ore carriers** of 30,000-ton capacity each have been ordered from English ship builders for delivery in 1955, President George M. Humphrey of the M. A. Hanna Co. has announced. They will be used to carry ore from the Labrador-Quebec operation to Montreal, Philadelphia and Baltimore.

★**Inland Steel Co.'s** new ore carrier, the Wilfred Sykes, passed through the Sault locks on May 23 with the largest cargo in Great Lakes shipping his-

tory: 20,084 gross tons of iron ore bound for Indiana Harbor, Ind. It averages 2½ round trips a week.

★**Fifteen new ore boats** have been ordered for Great Lakes traffic for delivery in 1952 and 1953. The Pittsburgh Steamship Co. (U. S. Steel), Ford Motor Co., Bethlehem Steel Co., Columbia Steamship Co., Inter-Lake Steamship Co., Cleveland Cliffs Iron Co., Pioneer Steamship Co. and American Steamship Co. are among those which have ordered the new ore carriers. The big boats will cost approximately $6 million each.

★**R. T. Elstad,** president of **Oliver Iron Mining Co.** has announced that all rail shipments of ore from Oliver mines will continue this season due to the intense demand for iron ore needed to fulfill the requirements of our defense program and essential civilian needs. Last year's all-rail shipment amounted to about 1.5 million tons. It is expected that the total industry all-rail shipments for 1951 will exceed 4 million tons, depending on the ability of the railroads to supply gondolas and hopper bottom cars. In addition ore shipping companies are using every possible means to keep their ore boats busy on the Great Lakes instead of being tied up at docks or returning light. Some steel companies are cutting their smaller boats in two and inserting new mid-sections to boost cargo capacity.

MONTANA

A.C.M. pushes Butte Project —Interest shown in chrome — Car of uraninite ore shipped

★Anaconda Copper Mining Co. is continuing vigorously with the construction of surface facilities and mine preparation for the Greater Butte Project, involving the mining and treatment of low grade ore from large areas of copper bearing material surrounding normal vein structures in the eastern portions of the Butte District. It is expected that production from the Project will be 6,000 tons of ore per day in 1952. The output will be increased to 10,000 tons of ore per day the following year, with an eventual output of 15,000 tons per day of the low grade ore. These daily tonnages will result in copper productions at the respective rates of approximately 40, 60 and 90 million lb. annually, in addition to the copper production from operations in the normal high grade Butte vein structures.

Anaconda has enlarged its zinc concentrator, increasing its capacity from 2,000 tons of zinc ore to 4,000 tons per day. The ferro manganese furnaces of the company have been equipped with voltage regulators and combined

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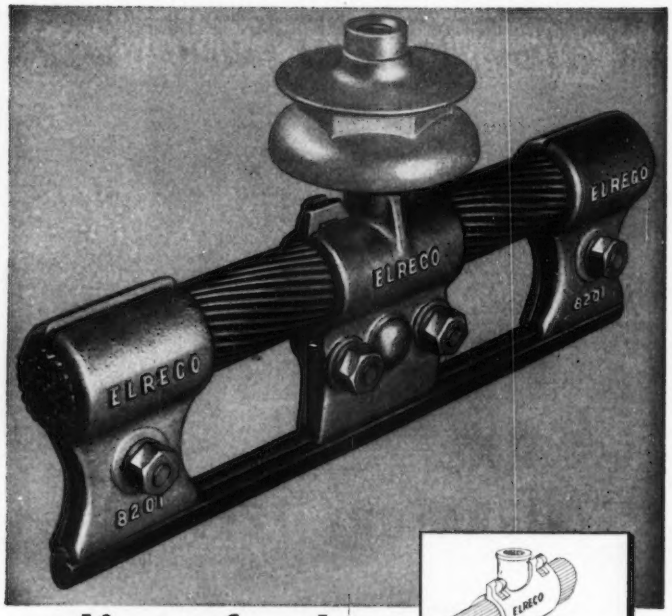

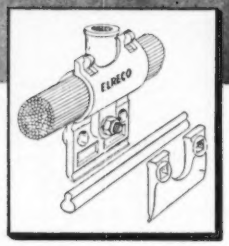

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Montana *(Continued)*

capacity of the 4 furnaces at Anaconda and the one furnace at Great Falls now is 35,000 long tons per year.

★There are semi-official reports in circulation that **Goldfield Consolidated Mines Co.** of Nevada, and others, have taken an option on the Mouat chrome mine in Stillwater county, which produced about 30,000 tons of chrome concentrates during World War II. It is reported that the new operators have applied for a Government loan to resume operations at the property.

★**Victor Chemical Works** is pushing construction of its $10 million elemental phosphorus production plant at Silver Bow, west of Butte, so as to have part of the plant turning out phosphorus during the fall of 1951. The remainder of the plant is scheduled for completion in the latter part of 1952, or before.

★It is expected that there will soon be two plants producing tungsten concentrates in Montana. **H & H Mining Co.**, operating a gold dredge in Henderson Gulch, Granite county, is producing high grade tungsten concentrates as a by-product from its gold placer operations. **Alps Mining & Milling Co.**, which built a concentrator near Clinton to treat gold ore, has purchased a large group of claims containing tungsten (ferberite) ore. The company is adding to its mill so that it will be able to handle 100 tons of tungsten ore per day in addition to its gold ore.

★**Montana Phosphate Products Co.**, the largest producer of phosphate rock in Montana, near Garrison, Powell county, is increasing its production to the extent that manpower and material will allow. There are a number of smaller phosphate producers in western Montana who are preparing to start operations.

★**Zonolite Co.**, the largest producer of vermiculite in the United States, is ready to expand its operations as defense requirements warrant.

★**Taylor-Knapp Co.** and **American Machine & Metals, Inc.**, at Philipsburg, Granite county, which are the largest manganese dioxide producers in the United States, are now supplying this material for defense work and probably can supply larger quantities if needed.

★In Butte, **Domestic Manganese & Development Co.** has been promised a Government loan to resume operation of its mill to concentrate manganese from Philipsburg and the western portion of Butte. The operators who expect to supply the crude ore for the mill are awaiting action by the Government to supply financial assistance. There is a potential deposit of manganese ore in the Cooke City district, Park county, which may be opened for production in the near future.

★**Steatite talc** is being produced by

Tri-State Minerals Co. near Dillon, Beaverhead county, and by the former **Mountain Talc Mines**, south of Ennis, Madison county. Both of these properties are in the hands of experienced operators who will meet increased demands for their output.

★**Chromium Mining & Smelting Co.** of Canada has conducted a survey in Montana looking toward the establishment of a chrome smelter near Glendive, Dawson county, to utilize the low grade chrome ores from the Benbow mine, Stillwater county, from which production was obtained during World War II. No definite plans have yet materialized for building the plant.

★**Harvey Machine Co.** of Torrance, Calif., has incorporated a Montana subsidiary and has purchased ground at Rose Crossing, near Kalispell, Flathead county, and near the Hungry Horse Dam. The company has made definite plans to build an aluminum reduction plant on its Montana property, which it is said will ultimately add 72,000 tons or more per annum to the production of aluminum in the United States.

★**North Butte Mining Co.**, with copper and zinc properties on the Butte hill, expects shortly to produce around 500,000 lb. of copper per month from leaching operations underground and in its surface dumps. Later on the company expects to mine zinc ore from hitherto undeveloped properties.

★**Search for uranium ores** in Montana is centered mainly in Jefferson county, where **Newmont Mining Corporation** is prospecting through a tunnel in the Alhambra District. Similar operations are being conducted by individuals near Basin and Clancy. **Elkhorn Mining Co.**, near Boulder, recently shipped a car of uraninite (pitchblende) ore, which is said to be the first full car of that kind of radioactive mineral ever shipped from this state.

NEVADA

New copper mine projects hold spotlight — Manganese, tungsten, fluorspar properties get under way

★Requirements for stepped up defense production have resulted in greatly expanded activities in Nevada copper mining.

The biggest development in recent months was **Kennecott Copper Corp.'s** announcement of expansion at Ruth to be completed in 28 months which will increase output by 8,000 tons of copper ore daily. The $7,000,000 program calls for a 1,700-ft. shaft, developing underground haulage facilities and installations for block caving, construction of a rail spur, enlargement of mill facilities at McGill and moving of a major portion of the

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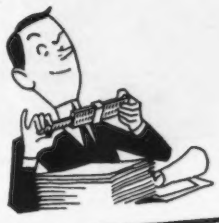

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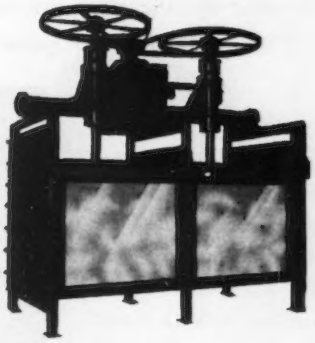

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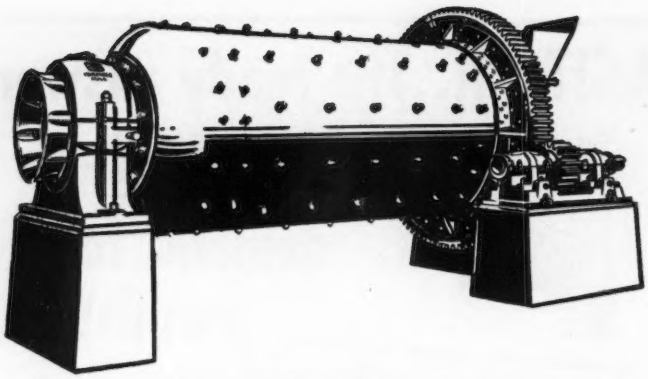

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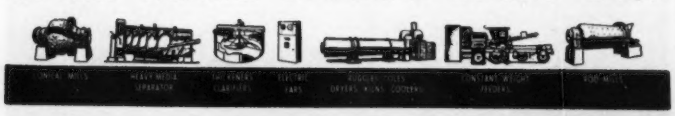

Nevada *(Continued)*

town of Ruth. Production is expected to start within 30 months after the shaft is collared. Initial cost of the project is estimated at $7 million and a capital investment of more than $13 million will be involved in addition to operating costs.

★**Consolidated Coppermines**, spurred by defense demands, reopened its Morris Brooks mine containing several million tons of potential ore. A two-year contract was let to handle some 15 million tons of material to open the pit. The operation is expected to supply the firm with about 50 million lb. of copper this year and next.

★More activity in the Nevada copper picture was seen when the **International Smelting & Refining Co.** started development work on a copper property near Yerington. The company plans a new town west of the Walker River adjacent to the former Guild-Adams properties, and eventual construction of a smelter.

★Two firms have been interested in **Nevada manganese** in recent months. **Manganese, Inc.** announced plans for a $2 million development north of Henderson. Part of the old Hanna plant, which operated unsuccessfully during the last war, will be used in the expansion project. The mill will have a capacity of 1,200 tons daily.

Also active in manganese is **Combined Metals Reduction Co.**, which operates a large mill in Lincoln county. The company plans to treat manganese concentrates at the Basic Magnesium Inc. plant at Henderson, inactive since the war.

★**A large scheelite deposit** in the Alder mining district 25 miles east of Mountain City in Elko county has been reported by A. A. Knowles and Price D. Montrose, who have started developing the property. The ore occurs in a highly metamorphic area on a lime granite contact. The strike of the orebody is east-west and about 2 miles in width. State and federal geologists who have inspected the property describe it as one of the largest of its kind ever discovered.

★Another new tungsten operation, backed by Canadian capital, is underway in the Pinenut Mountains east of Minden. **Canadian American Tungsten Co.**, which owns the property, has sent its own crew into the district to begin work. The ore will be hauled to a mill at Sodaville which has contracted for 3,500 tons. Lease of a mill in the Virginia City area is also being negotiated.

★**Black Horse mine** in Esmeralda county is shipping 40 tons a day of good grade scheelite to mills. More than 11,000 yd. of overburden has been removed from the face of a 250-ft. hill exposing the vein which varies from 16 to 30 ft. in height.

★**H. W. Gould & Co.**, San Francisco,

plans construction of a $500,000 mill to process fluospar at its recently acquired Baxter mine between Fallon and Gabbs Valley. The new plant will be capable of treating 250 tons of ore daily. The deposit is 450 ft. deep, 3,750 ft. long, and entered through four shafts.

★**Perlite** is being produced in quantities of 400 tons daily from the Hollinger pit in Lincoln county, run by Combined Metals Inc., with Aften Bohn as superintendent. The ore is processed at the Panacalite mill.

NEW MEXICO

Carlsbad's business booms—A mica mine opens—Perlite production climbs — Beryl mined at Harding

★**The war in Korea** stopped a downtrend in mining in New Mexico and the industry has been gaining fast ever since, with the non-metallics, as usual, in the lead.

★**Potash** led the comeback parade after a hard year, what with foreign competition getting back on its feet and a 73-day strike tying up things for nearly 4 months (1949-1950).

The three potash mining companies in the Carlsbad district resumed their $6 million improvement and expansion program in the spring of 1950, and budgeted half that much again for 1951. Their business fell heir to a big upsurge in the use of fertilizer in this country, as eastern farmers went in for cattle raising on run-down land, and the middle west turned to hybrid corn in a big way—hybrid corn being a potash-hungry plant like cotton and tobacco.

★Two new potash enterprises got into the Carlsbad field during 1950. **Duval Sulphur and Potash Co.** will start getting out potash ores by the first of 1952, and **Southwest Potash Co.**, subsidiary of the **American Metal Co., Ltd.**, will be producing by July. Each of these companies will spend around $10 million in setting up shop, and each will be scouting for about 500 men six months from now.

★Potash production in 1951, with three companies active, United States Potash Co., International Minerals & Chemical Corp. and Potash Co. of America, will run a good deal over one million tons of refined salts.

The newcomers in the field, where already ⅚ of U. S. potash production comes from, are gathering skeleton crews of supervisory men as follows:

Duval Sulphur & Potash Co.: W. Page Morris, general superintendent; G. E. Atwood, mill superintendent; J. E. Tong, mine superintendent; J. W. Borskey, chief chemist; and G. C.

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New Mexico *(Continued)*

Weaver, consulting engineer. The first three were formerly with International Minerals & Chemical Corp., potash division, Carlsbad.

Southwest Potash Co.: F. H. Stewart, superintendent; Aubrey Smith, assistant superintendent; Victor Bongard, mine superintendent; I. A. Herbert, chief engineer.

★Another development in New Mexico during the past year was the discovery and exploratory development of a large field of **low grade uranium ore** near Grants. Much of the new field is on land owned by the Santa Fe Railway Co., which is taking the lead in proving up on what's there and how much. So far it's open pit work.

Over 100 miles to the north, other uranium deposits have been located around the "Four Corners" country, including land in the big Navajo Indian reservation. **F. H. Sitton, Inc.,** of Cortez, Colorado, was given a lease on 160 acres for a uranium mill.

★**Mex-Tex Mining Co., Inc.** remodeled and enlarged its mill at San Antonio to process complex ores containing fluorspar, lead and barite. This in connection with a flurry of production in the old Hansonburg district, where the ore comes rich in spots, but is a considerable distance from a paved highway and the mill. Principals: J. E. Bishop, W. R. Cullins and Ben B. Scott.

Other operators getting Hansonburg ores are the **HurlowMining Co., Inc.,** and the **Portales Mining Co.,** with jig mills at San Antonio.

★**Great Western Mining Co.** got in on the rising market for scrap mica by setting up a 40-ton mill at Mora, and arranging to double that capacity in 1951. Rufus Little, Santa Fe, is president; Robert Katson, Albuquerque, secretary-treasurer, and John Habrel, engineer in charge.

★**Kennecott Copper Corp., American Smelting & Refining Co.,** and **United States Smelting, Refining & Mining Co.,** all stepped up production from dormant lead-zinc mines in the central district in Grant county. Kennecott also worked up to peak employment at its Chino Division copper operation at Santa Rita and Hurley.

★**Perlite production** in New Mexico climbed last year as **Great Lakes Carbon Corp.** enlarged its plant at Socorro. The plant is now shipping 125 to 150 carloads a month to processing plants owned by Great Lakes Carbon in various parts of the country, and is shipping some sized material to foreign markets.

W. D. Stone is superintendent at the Socorro operation. Mining consists of taking a Caterpillar D-8 tractor with Carryall scraper and cutting down several hills. On one hill they have taken off 70 ft. and are still in clear, white, uniform perlite rock.

★**Pumice production** in New Mexico continued at a high rate. The large volume goes into building block aggregate. But the state got its second producer of refined commercial pumice when **James H. Rhodes & Co.**, Chicago and Long Island City, entered the field at Santa Fe, near some of the better deposits. This company manufactures abrasives at Tarpon Springs, Fla., Chicago and Jersey City. Elmer R. Murphey, of South Pasadena, Calif., is president of the company. **Pumice Corp. of America**, Grants, has been in this business since the beginning of World War II. James A. Freeman, Jr., is general manager.

★**Renewed demand for beryl** has brought the old Harding mine, near Dixon, to life, with owner Arthur Montgomery in charge. About 200 tons has been shipped of non-crystalline beryl, probably the largest tonnage this year from any domestic mine. Work at present is being done by Chapman & Wood, Alburquerque, on a similar rich deposit in the mine.

★**New Mexico Mining & Contracting Co.**, Alburquerque, is mining lithium bearing ores at the mine under contract with Montgomery, having shipped about 1,500 tons in 1950. The Harding pegmatite is a flat-lying dyke about 3,000 ft. long. The central area is exposed as a quarry. During World War II some 20,000 lb. of high grade tantalum concentrates were produced.

★A number of manganese producers in New Mexico got busy when **U. S. Ferro Metals Co.** built a mill at Deming to stockpile this metal for the defense program. Col. E. Arthur Kerchbaumer, chairman of the board, established an office in Santa Fe in March, 1951, and announcement was made that the company had received a contract for 50,000 tons of manganese for the defense program.

★**Southwest Minerals Inndustries**, a Massachusetts trust, bought a rich manganese property near Socorro. Principals are George K. Kremm, of Chicago; D. D. Corum, of Warrensburg, Mo., and George F. Foster, of Los Angeles. This group is also in control of manganese mining in the Arizona Artillery Peak district. Large scale operations in New Mexico are planned.

★**Fluorspar**, of which there is a great deal in various parts of New Mexico, also felt the effect of the defense program during the past year. One fluorspar property, **the Universal mine**, near Truth or Consequences, hadn't been worked since 1934, but now is shipping two cars of ore a week. The owner is Blanchard Hanson, of that area.

The fluorspar division of the **Gloria Mining Co.** of El Paso, Texas, has reopened the Animas mine 13 miles south of Lordsburg, and is doing development work there. C. J. Burnett is supervising the work.

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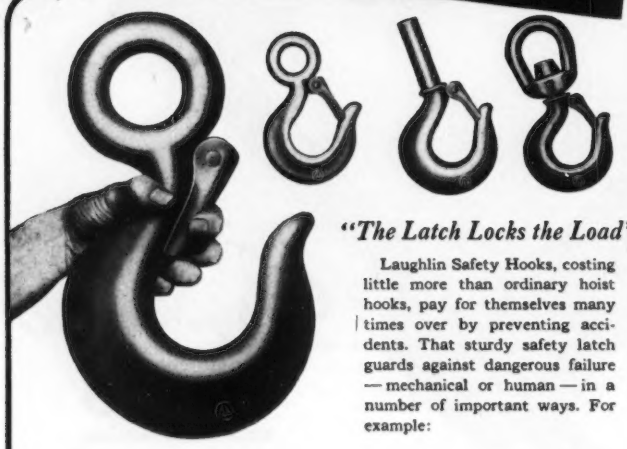

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New Mexico *(Continued)*

★**The General Chemical Division, Allied Chemical and Dye Corp.,** is operating its fluorspar mill at Deming, at capacity. The corporation owns the Shrine fluorspar mine in Grant county (north of Deming) and is doing development work on its Fluorita mine in Luna county, nearer to Deming. The mill is purchasing ore on a custom basis, also.

The Shrine mine was worked by Louis L. Osmer from 1936 to 1942. He took out 2,865 tons of ore running up to 83% CaF_2. General Chemical bought the mine in 1942 and stepped up production for the war effort. In 1948 a fire burned out the main shaft.

OREGON

Buying depot for chrome ore at Grants pass — Mercury mine working two shifts

★Following announcement by the General Service Administration that a receiving station will be established at Grants Pass for **metallurgical grade chrome ore,** G. J. Jameson, administration inspector, has been making a survey of chrome locations in southwestern Oregon. W. N. Grabill, regional information officer, has gathered information on chrome production costs and mineral potentials of the area.

★**Eastern Oregon Mining and Mineral Assn.** has voted to ask the Government to establish a chromite ore buying station in eastern Oregon, or appoint an ore buyer to sample and buy ore at the shipping point. The Association emphasized that mountain barriers between eastern and western Oregon would prevent trucking ore to the Grants Pass depot.

★**Bonanza mine,** big quicksilver producer during World War II, is being operated with two shifts, and underground exploration work is being carried on. The mine is located near Sutherlin in western Oregon. Burt Avery is mine superintendant at the Bonanza.

★**Howard C. Schoenike** has been appointed superintendent of the **Hanna Development Co.'s** exploration work on Nickel Mountain near Riddle. The area contains nickel deposits.

★**The Oregon State Department of Geology and Mineral Industries** has issued a handbook describing more than 300 mineral deposits in northwestern Oregon. Metallic minerals listed are gold, silver, copper, lead and zinc in districts of the Cascade range; quicksilver deposits in the Clackamas River area, limonite iron ore in areas along the lower Columbia River, and ferruginous bauxite deposits in several areas.

THE SOUTHEAST

Mica and kaolin producers seek new deposits—Feldspar plants built — Iron ore output rises

★**Rising prices** for most minerals and the stepped-up national defense program has greatly stimulated mining interests throughout the region. State mineral and geological departments are planning increased explorations and core drillings to discover new deposits.

★Big demand for **strategic sheet mica** has induced a number of interests to begin prospecting and exploration work in Chilton, Clay, and Randolph counties in Alabama. Mechanization of red ore mines in the Birmingham district is moving ahead rapidly. **Tennessee Coal, Iron and Railroad Co.** has added 9 trackless units since January and now has 14 in service. It expects to hit a new production record of over 5,750,000 tons this year, as against about 5,000,000 tons in 1950. TCI is putting into service 3 new diesel electric shuttle cars in its limestone mine and is installing automatic loaders. An air motor electric bulldozer will be tried in Muscoda to pile up loose ore for quicker loading. TCI's steel expansion program will lift ingot production from 2,850,000 tons to 3,350,000 tons by late next year.

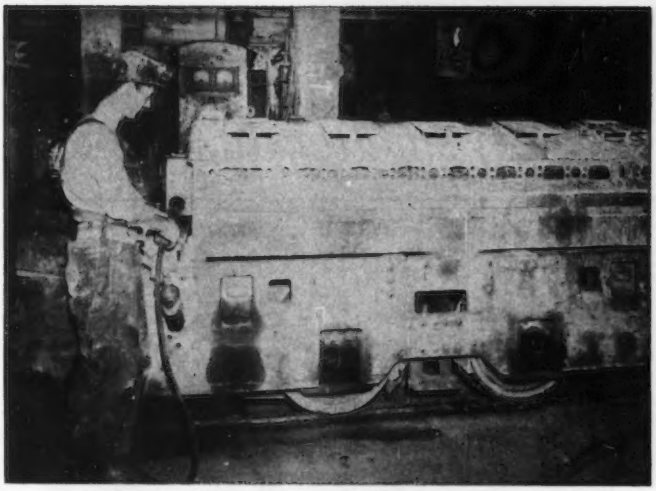
FLORIDA

★Big project in Florida is the uranium extraction and phosphate treatment plant being built at Mulberry by **International Minerals and Chemical Co.** Other phosphate companies are making additions to plant and upping output to meet defense and domestic demands. Fertilizer demands are especially great. The DuPont company operations at Starke have reached output of more than 100,000 tons a year of ilmenite in addition to rutile and zircon production.

GEORGIA

★**Kaolin producers** in the Sandersville area are expanding production as much as 75%. Bureau of Mines has worked out a process to obtain a higher grade of manganese oxide than has ever been possible in the past from the deposits in the Cartersville and Cedartown areas. This has stimulated mining interests to start additional explorations for richer deposits.

★**General Abrasive Corp.** has L. M. Richard in the northwest Georgia area working on a new bauxite deposit. The company has found good samples



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Georgia *(Continued)*

in deep deposits. More than 250,000 tons have been marked off so far. The company will move its processing plant from Arkansas to the area between Kingston and Adairsville.

★**The brown iron ore** companies report that average production has been increased more than 15% of late.

NORTH CAROLINA

★**Consolidated Feldspar Corp.** is rushing work on a new flotation plant to produce feldspar near Spruce Pine.

★**Foote Mineral Co.** is putting a spodumene plant at Kings Mountain into production. The plant was built originally by the Solvay Co.

★**Tungsten Mining Corp.** is enlarging its mine and mill in Vance county.

★Humphreys spirals are being installed to increase production at **English Mica Co.**, Kings Mountain, and **Harris Clay Co.** at Spruce Pine.

★**United Feldspar & Minerals Corp.** is opening a pyrophyllite deposit on Bowlings Mountain near Stem, Granville county.

★Efforts are being made in **western North Carolina** to increase mineral production of that area for defense purposes. The A.E.C. is said to be considering an extensive survey of the region for radioactive minerals. Approximately 45 mining men from 15 counties met in Asheville on June 8 to form tentative plans for a statewide miners organization to be discussed at a meeting, also in Asheville, on July 10. Jasper Stuckey, North Carolina state geologist, presided. Objectives of the association will be to supply all possible aid to the State's miners, both in legislative action and in provision of technical and economic information.

★Exploration crews of **National Lead Co.** have set up a field office at Manteo, and are drilling in the Dare county beach sands in search of ilmenite.

UTAH

New tunnels at Bingham — Park City hits ore — Combined Metals gets exploration contract

★**A pair of major ore haulage tunnels,** a new hoist scheduled to double the output of a once "dying" district, an increased demand for uranium, clays and hydrocarbons, have combined—with the availability of matching Government funds for exploration—to markedly brighten the metals picture in Utah.

★Two principal mine-field undertakings that will eventually boost production, or at least maintain present high levels, will not pay off for operators until 1952 or later. These include the 21,014-ft. long, ore haulage bore recently holed through (April 16) by Utah Construction Co. crews for the **United States Smelting, Refining & Mining Co.** operations near Bingham.

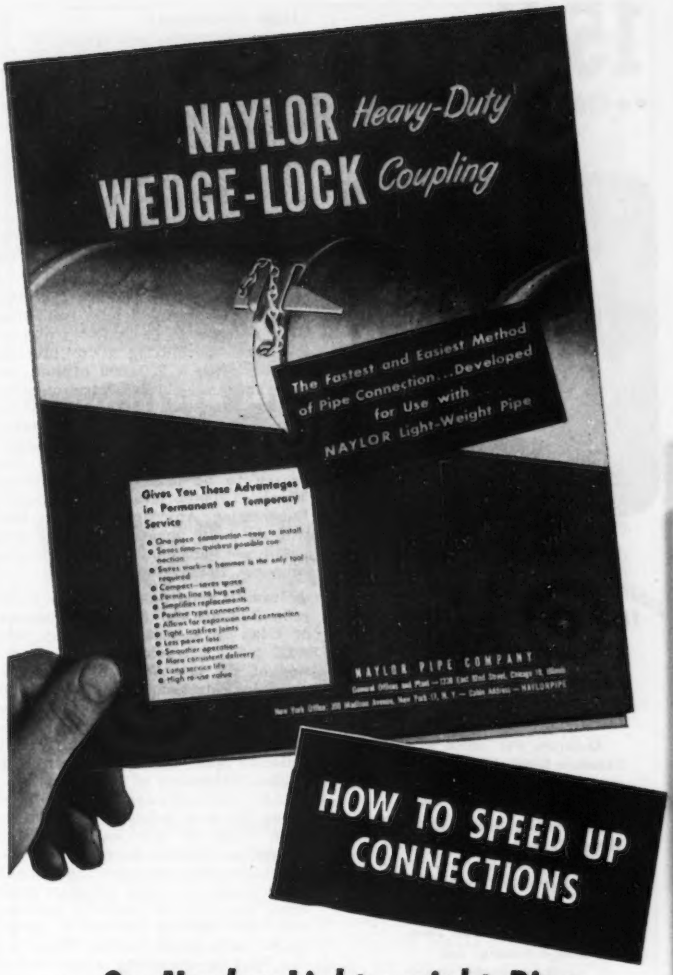
This railroad-sized tunnel, slated for completion in mid-1952 after lining, tracklaying, and ventilation work is completed, will bring ores from USSR&M's Oquirrh Range mines to a common portal for haulage to the company's lead-zinc smelter at Midvale, Utah. Begun in 1948, the tunnel will cut haulage costs, make for more efficient operation, and should thus insure continued profitable operation of one of the most important diggings in Utah.

★A 7,540-ft., railroad-width ore haulage tunnel likewise being driven for the **Kennecott Copper Co.** in the same range has equal significance, in this case insuring continued smooth haulage operations at Kennecott's mammoth Bingham open pit mine, largest in the U.S. Slated for completion in April, 1952, this bore will afford connection between the mine's 5,840-ft. level to Kennecott's present railroad system in lower Bingham Canyon. Kennecott's Utah diggings sent 554,995,248 lb. of copper to market in 1950, a 6-yr. production record. Totals for the initial half of 1951 are expected to be equally high, despite short-lived work stoppages at Kennecott's mills and refineries in May prior to contract negotiations.

★A joint operating venture of **Park Utah Consolidated Mines Co.** and **Silver King Coalition Co.** has resulted in valuable new discoveries along the area where properties intersect, with all parties concerned benefiting from the cooperation currently enjoyed. After reopening in Oct., 1950, Silver King's 700-ton mill has been in steady operation at Park City, handling some 250 tons of lead-zinc ore daily.

Meantime, Park Utah crews banged into a new orebody in the Ontario section of the mine while at work on an interior shaft. Paul Hunt, vice president and general manager of the company, reports some 45 ft. of this new orebody now penetrated. Apparently a porphyry rather than bedded ore, the find is reported of good grade, and was encountered while a shaft was being raised from the 1,700-ft. to the 1,500-ft. level. The new shaft part of the development program under way, will have a capacity of 6,000 tons of ore per month.

★Nearby, Park City's other major operation, **New Park Mining Co.**, is installing a new high-speed Nordberg hoist, which, according to W. H. H. Crammer, president, should double the production of lead-zinc-silver which now stands at 6,000 tons a month. The hoist will permit mining of additional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Utah *(Continued)*

levels below the present 1,300-ft. mark. It will have 250 hp. as against the old 60-hp. unit slated to be kept in service to handle supplies. New Park is seeking Government assistance for a matching program of $250,000 for extension of its current Mayflower Tunnel west from the presently known orebody, plus crosscuts north and south from present operations. The concern meantime is mining uranium ore at Circle Cliffs in Utah's Garfield county.

★Another "old line" firm in the region, **Combined Metals Reduction Co.**, has received Government matching funds permitting it to proceed speedily with a $200,000 exploration program in the old Ben Harrison mine in the Stockton district of Tooele county. President E. H. Snyder states that a mile of drifting and crosscutting is projected, with the approach to be made from Combined Metals' 1,200-ft. level in the present Bauer mine. Any significant ore find will naturally insure continued, and possibly expanded, operation of the concern's Bauer smelter.

★**Uranium activities** in both the Colorado Plateau and Marysvale sectors of Utah have been spurred by new AEC price schedules, and by operation of the new **Vitro Chemical Co.** plant in Salt Lake City. About 100 tons of Marysvale ores are now being reduced to uranium salts daily at this installation, the former World War II Kalunite Plant erected at a cost of $5 million. Shipments of Marysvale ores to AEC stockpiles are known to total about 175 tons daily from the **Vanadium Corp. of America** leases, the Seegmiller claims, Bertelson claims, and Bullion Monarch operations. While the tonnage is mostly autunite, some cores have showed uraninite crystals, and AEC diamond drilling is known to be heavy in the region. Meantime, the VCA is operating a processing mill at Hite, Utah, and the Galigher Co. of Salt Lake City is operating an AEC mill at Monticello, Utah, with the output of Colorado Plateau ores not reported.

★Lesser known operations dealing with more uncommon substances are likewise booming in Utah. In Juab and Millard counties, **fluorspar mining** activities have greatly expanded, with shippers loading 19,250 tons of fluorspar in 1950 and doing at least as well this year, an increase of 130% over the 1949 tonnage. The material is shipped to satisfy the needs of the Geneva Steel Co. at Provo, and much is also going to steelmakers in Illinois, as well as for the manufacture of hydrofluoric acid.

★In another chemical activity tied to the mining field, the **Garfield Chemical & Mfg. Co.** at Garfield, linked in ownership to American Smelting & Refining Co. and Kennecott, will shortly double sulphuric acid produc-

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tion when its new plant comes into use. In addition, the Garfield firm has been granted accelerated tax amortization of 70% on an amount of $3,583,000 by the Defense Production Administration, to further speed the production of sulphuric acid.

★Adjacent to this plant at Garfield, **Howe Sound Refining Co.'s** cobalt refinery is due to begin production by late summer. **Calera Mining Co.**, a Howe Sound subsidiary at Salmon, Idaho, has received a General Services Administration contract for the purchase of 2,000,000 lb. of cobalt between July 1, 1951 and June 30, 1952.

★Meantime, partly due to defense needs, two little-known Uintah Basin hydrocarbons are finding an increased market. Gilsonite, mined through open pit methods in the Eureka and Bonanza areas, is being shipped through the Salt Pipe Line Co. oilfield pipeline to the Salt Lake Refinery Co., where it is to be utilized to round out residual fuel oil supplies for a new Utah Power & Light Co. generating plant. Much of the gilsonite output continues to go back to the resin, paint and battery industries.

In addition, elaterite, somewhat similar to gilsonite, is now being mined from fissures in Wasatch county for retorting into a residual gum used by paintmakers. The paints with an elaterite base provide high-type protection against salt water and barnacles. About one ton daily is being retorted at Midvale.

★In a much larger operation, halloysite clays are now being mined both in open pit and shaft operations in Juab county by the **Dragon Consolidated Mining Co.** Sent to the new $3,500,000 plant of the Filtrol Corp. in Salt Lake City, the clays are processed for the manufacture of a catalytic agent used in oil refineries.

WASHINGTON

Grandview gets new hoist — Pend Oreille to start second unit soon; income rising

★A new hoist is to be installed by **American Zinc, Lead & Smelting Co.** at the Grandview mine near Metaline Falls, for greater efficiency and to maintain the 800-ton daily production at the new 300-ft. level, which is 100 ft. below present working level. It will have a 200-hp. rating and will lift ore 600 ft. a minute, in comparison with the present 75-hp. which lifts 250 ft. a minute. It will operate in an inclined shaft which has been driven downward 60 ft. at an angle of 22 degrees to the present underground hoist room. The inclined shaft extends 1,210 ft. past the underground room. Approximately 140 are employed and 35 more could be put to work if available.

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Washington *(Continued)*

★Reconditioning of the war-time dolomite plant at Marble, near Northport, was begun in May by **Morrison-Knudsen Co.** of Boise, Idaho. Quarrying is to be resumed by **Pacific Northwest Alloys**, subsidiary of **Chromium Mining & Smelting**, which operates the plant at Mead. In this same area near Northport, Spokane Portland Cement Co. is employing about 40 men in production of limestone for its cement plant at Irvin, and for paper mills at Millwood and on the Coast.

★**Delemar Mining & Recovery Co.** of Spokane has asked permission of the SEC to raise $125,000 by selling 500,000 shares of stock in order to buy machinery, increase its mill capacity, and further develop and explore its property at Harpster, Idaho. Officers from Spokane are Arthur E. Daniels, president; Roy A. Daniels, vice-president, and Larry L. Lincoln, secretary-treasurer.

★It is reported from Colville that industrialists from the Coast plan to spend $250,000 to start production at the **Frisco-Standard** lead-silver-copper mine in Stevens county, where $20,000 was spent in prospecting last year. The property is in the vicinity where both Hecla Mining Co. and Day Mines, Inc. have recently acquired interests.

★**Kaaba Consolidated, Inc.**, of Nighthawk, filed notice with the SEC office in Seattle that it plans to make an offering under regulation A of 3,051,911 shares of common assessable capital stock, par 25c, to Kaaba Silver Lead Mines. Inc. Money raised through assessments levied would be used for current operating capital and to pay off indebtedness.

★**Glacier Mining Co.** is reported to have discovered some rich copper ore northeast of Glacier on the Mount Baker Highway, according to Robert Boad, vice-president, who says assays have also shown good content of gold and silver. Early in May he predicted shipments from the mine to Tacoma "within a month."

★**Pend Oreille Mines & Metals Co.**, which operates a 500-ton mill at its older plant west of the Pend Oreille River at Metaline Falls, expects to put the second of its 800-ton mill units in operation during the third quarter of this year.

★Interesting developments are reported from the Swauk area in Kittitas county. According to Ed Mangan, foreman for **Nugget Properties, Inc.**, operations were to be in full swing the first of June. A bulldozer and large suction pump were added to other equipment for gold placer mining this season. Properties of Robert Bowman and Donald Price on Snowshoe ridge are being operated, and they have leased some ground to a Mr. Stewart and associate who have taken in an air-compressor for work nearby.

IN CANADA

Golden Manitou has rich present, better future—Uranium strike in Saskatchewan —B.C. mines enjoying boom

★First details have been released on one of Canada's **most secret current projects**, a uranium development that may prove of greater importance than the Eldorado mine at Great Bear Lake. The new development is at Beaverlodge Lake in the far northwestern part of Saskatchewan, still on the Pre-Cambrian shield that makes up half the land area of Canada. The site is about 500 miles south of the Arctic Circle and about 500 miles north of Saskatoon. Mining will probably begin in early 1953, under the direction of the Government's Crown Company, **Eldorado Mining & Refining Co.**, of which W. J. Bennett is president. The discovery is the result of 5 yr.'s painstaking work by the Eldorado staff. Official comment on the size of the orebody is lacking, but it is known that a production greater than that of Eldorado is expected.

QUEBEC

★**Golden Manitou Mines** enjoyed the best year in its history in 1950, with net profits of 25.15 cents per share compared with 9.9 cents in 1949, and with ore reserves up from 1.2 to 1.9 million lb. of zinc, 2.3 million lb. of lead, 170,000 lb. of copper, and 1.1 million tons. This growing Bourlamaque base metal producer earned profits from 20.1 million lb. of zinc, 2.3 million lb. of lead, 170,000 lb. of copper, and 1.1 milion oz. of silver. Features of the mine's development during the year were the opening of the East ore zone, a new section well above mine average in grade, and the discovery of the copper zone in which drilling has indicated 1 million tons averaging 2.5% copper. A new shaft will be required to open up the latter showing. The company now has two promising outside bets in addition to the original mine.

Small but with good promise of profit is the **Mastodon zinc mine** near Revelstoke, B. C., in which Golden Manitou will have a 50% interest. This property will be in production next year with a 150-ton mill.

Golden Manitou's other outside project is its 53% interest in **Barvue Mines**, star performer in the Barraute area north of Amos, Que. Barvue is being groomed for open-cut production on a starting basis of 4,000 tons daily. Surface drilling has outlined 17.3 million tons of ore averaging 3.26% zinc and 1.13 oz. of silver per ton. A contract has already been made with American Zinc, Lead & Smelting

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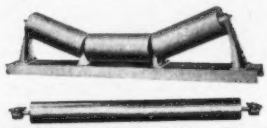

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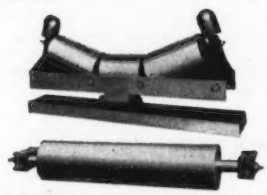

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Co. for 175,000 short tons of Barvue concentrates, at a price of 17.5¢ per lb. of contained zinc (U.S. funds). This, it is estimated, will account for all the first 2.5 yr.'s output; gross value being close to $35 million. Plans call for initial production early in 1952.

★Plans should soon be on the drafting board for mill construction by **Montauban Mines,** lead-zinc-silver prospect adjoining the Anacon mine in Portneuf county. Shaft-sinking is being started, with two levels to be opened at 150 and 300 ft. to prove the 400,000 tons of ore that were indicated by surface drilling. Suggested grade is 2.72% zinc and 0.74% lead. Production plans are being based on a starting rate of 500 tons daily, and the first concentrates will possibly be shipped early next year.

★Another group of old Quebec properties being revived under the stimulus of 1951 metal prices includes the **Huntingdon, Ives, and Bolton mines** in Brome County, Eastern Townships area, some 70 miles east of Montreal. They have been taken over by the newly-formed **Quebec Copper Corp.** and will be extensively explored this summer. History of these copper prospects goes back to the 1860's but all have been idle for many years.

★Net profits of **Normetal Mining Corp.** were off slightly in the first 1951 quarter; 19 cents per share versus 23 cents in the final quarter of 1950, though well above those of the March quarter last year. Higher costs and taxes were responsible for the reduction. Interest at the property this year is focussed on two new developments; the construction of a pyrite treatment plant to handle mill tailings for daily output of 175 tons of concentrates, and a drive going out on the 2,300-ft. level to explore the adjoining property of Noralmac Mines. The latter is a reorganization of **Alamac Mines** and will be controlled by Normetal if its options are exercised.

★This will be an important exploratory year for **East Sullivan Mines,** for work is well started on the new deep levels opened in 1950 by shaft-deepening. The results will have a marked bearing on the mine's future, for little is yet known about ore deposition at depth, and the company hopes to find a repetition of the big, wide orebodies now being mined above the 600-ft. level. The operation isn't being hurried, for the 4.9 million tons of known ore will keep the mill running easily for at least 5 yr. at the 1950 production rate. Profits last year were $1.44 net per share, compared with 67 cents in 1949.

ONTARIO

★Net profits of **International Nickel Company of Canada** in the past two quarters were the best in its history:

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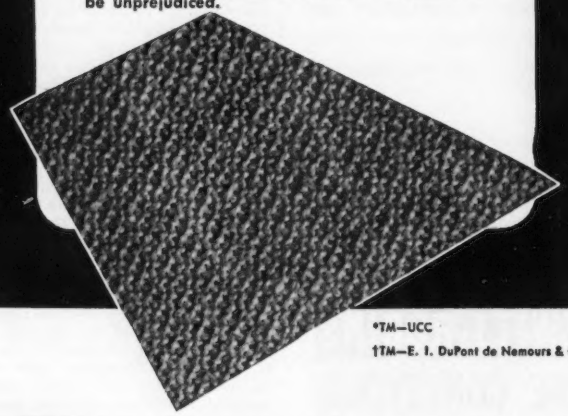

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Ontario *(Continued)*

98 cents per share (a record) in the closing period of 1950, and 97 cents in the opening three months of 1951. The closest approach to these showings was made back in 1937 when earnings of 93 cents were rung up. While costs have risen sharply this year especially wages, they will be largely offset by increased quotations for nickel, which the company at the start of June upped by 6 cents per lb. to 56.5 cents.

★This is the busiest year in a great many for the silver-cobalt camp at Cobalt. Sparked by the high prices now existing for both metals, the old camp is the scene of more activity than it has known for more than a quarter of a century. Outstanding are **Silver-Miller Mines**, already a regular dividend payer and **Cobalt Lode Silver Mines**, which will make its first distribution in October, and which has added substantially to reserves since last November.

BRITISH COLUMBIA

★**One of the biggest metal booms in history** is hitting British Columbia, with millions of dollars pouring into new mining and metallurgical developments. Aluminum, tungsten, uranium, base metals, are all part of the picture, with some of the continent's biggest companies and the Canadian government participating.

★**Aluminum Co. of Canada** is starting on its $500 million refinery project in Tweedsmuir Park area; **Consolidated Mining & Smelting Co. of Canada** has $65 millions earmarked for development; the Dominion government is back in the tungsten business; American and Canadian firms alike are exploring for base metals, iron ore, copper, uranium.

★More than half a dozen mines have gone on a milling basis in the past nine months; a dozen more will begin milling by the end of this year; and presently announced plans, together with recent new plants, will boost milling capacity for base metals in the province by more than 5,000 tons daily within the next year or two. Even gold mines are deserting their natural field by swinging over plants to base metals milling to the tune of more than 750 tons daily.

★**Biggest single development** is the Alcan project, first phase of which is underway, involving an expenditure of $160 million by scheduled production to start in 1954. The first phase calls for development of 400,000 electrical horsepower and smelting facilities to produce 80,000 to 100,000 tons (metric) aluminum annually. The company is currently spending about $1 million monthly, with about $23 million being spent for the entire year.

Already, contractors have pushed a 10-mi. road from Kemano Bay to the powerhouse site up the Kemano River and a dock is being built at Kemano Bay for steamship service.

Morrison-Kundsen already have spent or committed $12 million for supplies, equipment and materials in the power phase, while Kitimat Contractors, a group of eight B. C. firms, are doing the first work on the townsite at Kitimat and are expected to get the $200 million contract for town and smelter construction. Final contract is due to be signed soon, following clarification of some clauses.

★**Cominco's** $65 million program includes a $30 million power set-up for Trail-Kimberley operations, involving development of an initial 205,000 hp. on the Pend Oreille River toward an eventual $410,000 hp.

A $12 million revision of the lead smelting at Tadanac is being undertaken, while a $3.2 million addition to the zinc plant will boost output by 60 tons daily to a total of 500 tons daily.

Other projects are a $9 million fertilizer plant at Kimberley boosting output by 70,000 tons yearly. (Present output at the Trail operation is 560,000 tons); a $2,850,000 powerline across Kootenay Lake to Kimberley and Riondel; a $1,000,000 water revision at Tadanac; a $300,000 power revision at Warfield.

★In the mining field, **Cominco** is spending $3 million on rehabilitating the old **Bluebell mine at Riondel** and construction of a 500-ton mill, with production scheduled next year.

The company plans to bring **the HB silver-lead-zinc mine**, near Salmo, into production with a 1,000-ton daily concentrator within the next two years at a cost of $2,750,000. The **Tulsequah Chief and Big Bull** properties, near the Alaska border, are due for production this summer using the **Polaris Taku Mining Co.** concentrator in the same area, now under lease to Cominco for five years and modified for lead, zinc and copper.

★**Meanwhile, Cominco is producing indium,** for use in high grade engine bearings as an alloy, at its Trail plants; and production of iron and sulphur from Kimberley tailings, using an electric furnace, is under consideration.

★In other areas of B. C., exploration is going ahead on **iron ore deposits,** and the provincial government has clamped a reserve on iron and manganese deposits on crown lands to prevent "nuisance staking" by speculators which might hold up legitimate production. **Argonaut Mining Co.,** Utah Construction Co. subsidiary, is investigating ore deposits at Quinsam Lake on Vancouver Island, and **Hugo Neu Corp.,** San Diego, is drilling Texada Island iron deposits after optioning claims long held by Puget Sound Iron Co. of San Francisco.

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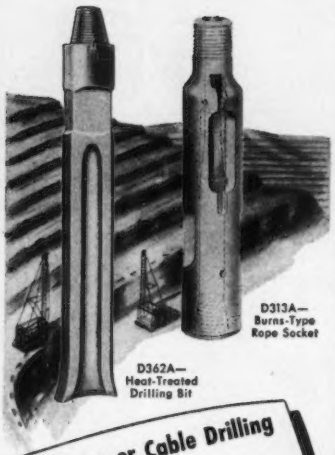

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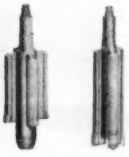

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British Columbia *(Continued)*

Hugo Neu plans call for shipment to Japanese mills by C. T. Takhashi Co., Seattle. Two other firms blocking out and estimating magnetic deposits on Vancouver Island are **Ventures Ltd.**, with claims in the Zeballos area, and **Quatsimo Copper-Gold**, with properties at the north end of the Island.

★**Resumption of tungsten production** for defense needs is planned at two properties. The Canadian government has repurchased part of the Emerald mine properties near Salmo from **Canadian Exploration Ltd.** for $328,000. Canadian Exploration, which purchased the Emerald property from the government after the last war for $950,000 and put it on lead-zinc production from the Jersey deposits, will rehabilitate the tungsten mine on a cost-plus basis and install and operate a 250-ton mill at government expense, treating both government and its own tungsten ore.

★**Western Uranium Cobalt Mines Ltd.** will reopen the Red Rose tungsten mine near Hazelton, with production scheduled late this year, under an agreement with **Consolidated Mining & Smelting Co.**, which operated the mine during World War II. A 75-ton mill is planned, which will be separate from Western Uranium's 150-ton mill on the Rocher de Boule copper-gold-cobalt property 3 miles away, scheduled for production this year. The company also will mine gold-cobalt-uranium ore on its adjacent Victoria claims, using a recovery formula provided by **Howe Sound Co.** and successfully used in the latter's Idaho operations. Meanwhile, radioactive showings on the old-time Smuggler Hill property near Kamloops are being investigated by Eastern interests.

★In the base metals field, even discarded ore in dumps, old mines and creek beds is helping to provide a boom in the Slocan area, with successful recovery being made possible by using a sink-float process in conjunction with a flotation mill.

Newest wrinkle in the procedure is the use of a Wemco "Mobil-Mill" Heavy-Media Separation unit, which will be moved around the country to the ore supply to cut down the amount of material trucked to the concentrator. Two sink-float plants and a flotation concentrator will be used, with center of operations at the Whitewater mine and concentrator at Retallack, now run by **Kootenay Belle Gold Mines Ltd.** The Retallack sink-float plant is being turned into a portable unit; the second such plant will be established at Sandon, 14 miles away.

An expansion program this year includes the Whitewater mine and six others in the Sandon area—the Altoona, Ruth-Hope, Richmond-Eureka, Elkhorn, Monitor and Payne. Kootenay-Belle plans to treat 180,000 tons

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this year, and estimates there are 590,000 tons of dumps to be treated and 160,000 tons of mine ore. Some of the ore dumps go back to the 1890's.

★Mines which have started milling include **Yale Lead & Zinc Mines Ltd.**, at Ainsworth, with a 250-ton daily milling capacity, and **Giant Mascot Mines Ltd.**, at the old Silver Giant mine at Spillimacheen, using the former Hedley Mascot Mines Ltd. gold mill with production aimed at 200 tons daily. A second ball mill will be installed, boosting output from the present 175 to 350 tons daily. Giant Mascot is a new company formed by Hedley Mascot and Silver Giant Mines Ltd.

★**Base Metals Mining Corp.** has brought two properties to production, with a new 100-ton mill in operation at Cork Province lead-zinc-silver property near Kaslo and a 150-ton mill at the Vancouver Island Base Metals property near Duncan on Vancouver Island. In addition, Base Metals is spending $150,000 to revamp methods and improve efficiency at its Kicking Horse mine at Field and to reopen the former West Monarch mine, idle for many years.

★**Kaslo Base Metals Ltd.** has scheduled production of a 50-ton diesel-powered concentrator at its Index group near Kaslo for August. The company was incorporated recently to develop the Index silver-lead-zinc claims which it acquired from Kaslo Silver-Lead Co., near the Cork Province mine, and the firm now has acquired the Budweiser, Amazon, and Spencer claims on Woodbury Creek near the Bluebell and Yale Lead and Zinc holdings.

★**Highland Bell Ltd.**, silver-lead-zinc producer at Beaverdell, swung its 50-ton mill into operation last autumn and expects the plant to pay for itself within two years, while **Violamac** at Sandon has a new gravity-flotation mill, and is widening ore reserves.

★**Kenville Gold Mines Ltd.** 150-ton mill, near Nelson, which ceased operations a year ago and later resumed under a six-months mine-mill lease to **F. C. Buckland**, now is doing double duty, treating lead-zinc ore from **Emerald Glacier Mines Ltd.** near Tahtsa Lake in the Omineca mining division, and high grade zinc ore from the Jackson mine of **Selkirk Mining Co.** at Kaslo. It was planned eventually to ship the Kenville mill to the Emerald-Glacier property in Tweedsmuir Park. and Selkirk was expected to build its own plant.

★**Kootenay Base Metals'** new East Kootenay base metal operation, financed by **Transcontinental Resources** and developing lead-copper-zinc claims in the Fort Steele district, has scheduled first ore shipments this summer and plans operation of a 60-ton mill before the year-end.

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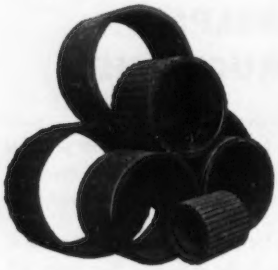

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British Columbia *(Continued)*

Cronin Babine Mines Ltd. is initiating a 50-75 ton mining and milling operation at its silver-lead-zinc property near Smithers.

★**Glacier Gulch Mining Co. Ltd.** has acquired a mill site near its mine at Smithers and plans a mill either on its own or in cooperation with other producers. **Western Exploration Co.**, which has a 250-ton mill at Silverton serving its three silver-lead-zinc mines, Mammoth, Enterprise and Standard, is installing a 500-ton daily sink-float plant which will treat ore from the mines and mine dumps.

★**Doreen Mines Ltd.**, a new company with gold-silver-lead-zinc operations near Hazelton, plans production by August with a 50-ton mill. **Estella Mines Ltd.**, at Wasa in the Kootenays, has named George W. Robinson resident general manager and plans to have lead-zinc ore going through its new 150-ton mill in July.

★**Santiago Mines Ltd.** is proceeding with plans for a 75-ton mill at the Bosun mine near New Denver, along with a 1,000-hp. hydro development.

★**Hamil Silver-Lead Mines Ltd.** is installing a 190-ton mill at its silver-lead-zinc property at Argenta. The Hamil mill purchased from the Velvet mine in the Rossland area is due in operation by the end of the year.

★In the Portland Canal area, the longtime gold operator, **Silbak Premier Mines Ltd.**, is developing and milling gold-silver-lead-zinc ore from the adjoining Northern Light property of **Premier Border Gold Mining Co.**, and will mine and mill **Indian Mines Ltd.'s** gold-silver-lead-zinc ore when a new aerial tramway from Indian Mines to the Silbak-Premier mill is completed. The tramway traverses Premier Border for most of its distances.

★**Hedley Yuniman Gold Fields Ltd.** has bought outright the Iota group of 19 claims and one fraction near Hedley and will move its complete gold mining plant from Bradshaw Mountain to the Iota silver-lead-zinc group west of Hedley. The Iota claims extend down a geological break to the Franklin group, also held by Hedley Yuniman.

★**Privateer Mine Ltd.**, former Zeballos, Vancouver Island, gold producer, is developing the optioned Neosha group of 17 silver-lead-zinc claims near Ainsworth; and **Sheep Creek Gold Mines** has acquired a sixth base metal property, the Mineral King in the Windermere area, with ore to be trucked up Toby Creek to the Paradise mill.

★Crews of **Consolidated Mining & Smelting Co.** are investigating the **Big Ledge Zinc** property opposite Nakusk on the Upper Arrow Lake, first staked in 1895 and held for 30 yr. by Nakusk interests, and optioned

IMPORTANT MAGNETITE BODY DISCOVERED BY AERIAL SURVEY IN A BLIND AREA

★

SEE PAGE 175 FOR DETAILS

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for 3 yr. by Cominco before it acquired rights.

Cominco has also optioned the Kinbasket group of lead-zinc claims from Kootenay Exploration Ltd. on Kinbasket Lake in the Big Bend area; and in another field, there are reports that Cominco may reopen North America's only major mercury mine at Pinchi Lake because of new high prices. The mine was closed down after the last war.

On its home ground, Cominco has initiated a program to extract 2 million tons of ore by open pit mining methods at its Sullivan mine at Kimberley. About a year's stripping operations will be carried out before mining of ore can start.

★Use of bulldozers and recent completion of a $3 million road, plus present prices—none available when previous mining attempts were made—have resulted in reopening of the **Atlin-Ruffner lead-zinc operation** in northwestern B. C. The new road makes possible trucking of ore from Atlin to the railway at Carcross.

★In the New Hazelton area, **Silver Standard** mine ore is averaging nearly $200 a ton, almost doubling the showing in two months, and in the same area **American Standard,** a new operation, is speeding up development and has awarded a contract for 7,500 ft. of drilling. Another new property, **Sil-Van Consolidated,** with the same directorate as Silver Standard, is expected soon to order mill construction for its gold-silver-lead-zinc operation. An exploration program is planned on the **Crown Silver Lead Mines** property near Hazelton.

★**Noland Mines Ltd.,** another Transcontinental Resources-backed company, which started deep-lead mining near Atlin on Spruce Creek last year, is investigating nearby claims acquired from Discovery Mines and Power Co. Ltd., while in the Salmo area D. I. Hayes, western manager of **American Zinc-Lead and Smelting Co.,** has optioned a group of 21 scheelite claims adjoining the Emerald Tungsten and HB mines.

★In the Ainsworth camp, **Woodbury Mines Ltd.** is launching three development projects on the Daisy, and Budweiser veins and on downward extension of orebodies, with ore being treated at the nearby mill of Ainsmore Consolidated which plans to increase its own tonnage by 25% when work gets underway on a new horizon.

★**Ainsworth Base Metals,** recently incorporated, is speeding up development on the former Black Fox silver-lead-zinc properties near Kaslo, Scanton Consolidated of Portland is undertaking a drilling program on properties near Ainsworth, and Carnegie Mines has been reconditioning the Silversmith at Sandon.

★**Silver Hill Mines Ltd.,** near Tulameen, was scheduled to ship soon

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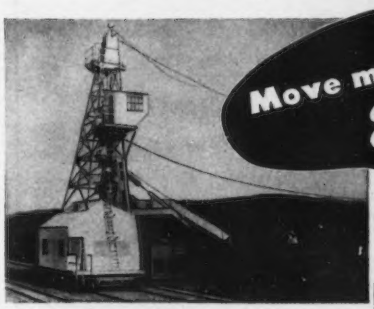

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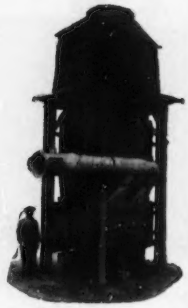

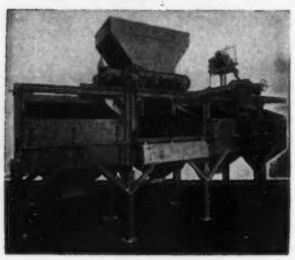

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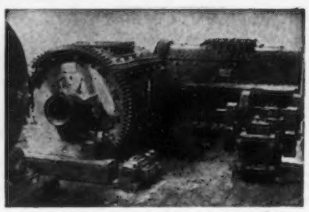

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British Columbia *(Continued)*

to Trail. **Guichon** is continuing shaft sinking and drilling at its Copperado property in Nicola mining division with a mill in prospect. **Reeves MacDonald** has opened a surface pit at its silver-lead-zinc property near Salmo supplying thus close to 40% of feed for its 1,000-ton mill.

★**Surf Inlet Consolidated** is investigating copper-zinc mineralization at the McVicar property on Howe Sound, near Britannia, where zinc production has exceeded copper output for the first time. In the Nelson district **Thomas Consolidated** of Spokane has transferred mining equipment to the Boy Scout property from its Idaho operation.

★Full-scale exploration has been started on **McDame Creek asbestos** deposits by **Conwest Exploration** with preliminary plans calling for an open-pit mine and sorting mill. A second firm in the field is **Pacific Asbestos Ltd.** of Vancouver, which is developing 8 claims in the same area.

IN EUROPE

★**Abandoned pyrite mines** are to be reopened to help relieve England's shortage of sulphur. Unable to get sufficient brimstone from the United States, England, perforce, must reconvert her acid plants to use pyrite roasters instead of sulphur burners. **Tharsis Sulphur & Copper Co.**, Glasgow Scotland, is one of the plants that will reopen pyrite properties.

★**The British Iron & Steel Corp.** is considering plans to merge firms working iron orebodies in Oxfordshire, Lincolnshire, and Northamptonshire. It is hoped that such a merger would result in greater efficiency and increased production. If accomplished, this would be the first important reorganization undertaken by this government-owned corporation since it took over England's steel industry Feb. 12.

★In opening new research laboratories in London, June 2, the **International Tin Research Institute** exhibited a new electroplated tin-nickel coating that is said to have better corrosion resistance and to use far less nickel than standard nickel plating.

★About half a million tons of **anhydrite** could be produced annually in Holland by working known deposits, according to the Dutch Geological Survey. Of this amount, 100,000 tons could be used as gypsum, 100,000 tons to produce plasterboard, 150,000 tons for ammonium sulphate, and 150,000 tons for cement and sulphuric acid. The anhydrite is found in eastern Holland in a layer about 200 ft. thick, estimated to contain about 150 million tons.

IN LATIN AMERICA

ARGENTINA

★According to a recent decree, the Argentine government will be the sole buyer of **tungsten ore, beryl, and mica** produced in the country. All purchases wil be made by the **Banco de Credito Industrial** and the minerals placed in the national stockpile. Any surplus will be exported by the government. The basic price of tungsten concentrate (25,000 pesos per ton at 65% grade) has been fixed by the government for the next two years. Any profit made by the bank on the sale of minerals will be returned to the producers, after deduction of expenses.

★A second charcoal iron blast furnace has been started up at the Zapla, Jujuy, property of **Fabricaciones Militares.** A reforestation program has been launched in the area to assure fuel supply.

★**National Lead Co.'s** project to open the Castano Viejo lead-zinc property is retarded by difficulty in obtaining imports of machinery for cable-way, power plant, and mill. Mine development is well advanced. Properly equipped, Castano Viejo could add some 6,000 tons of lead a year to Argentina's production of around 20,000 tons.

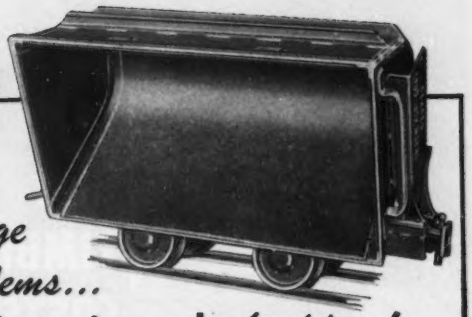
★**University of Tucuman and the Direccion de Industria Minera** are exploring the gold area of **Agua de Dionisio** near Hualfin in Catamarca. This area is now included in the Federal Reserve and the government shows keen interest in potential gold production from it.

BOLIVIA

★**Current favorable prices for lead,** tungsten and antimony are causing an upswing in Bolivian mining activity. The large companies and hundreds of small operators are all striving to push production to the limit. Manpower is the main limiting factor, with both labor unrest and shortage of men holding down production. Employment in Bolivian mines is estimated now at 55,000. The government is extremely concerned, however, about the RFC's recent price-cutting actions in respect to tin.

★**Regulations governing forced sale** to the government of drafts received for tin exports have been liberalized sufficiently to allow tin miners to carry on more or less normal operations. Tungsten miners, however, still operate under the decree of Aug. 11, 1950, which leaves very little margin of foreign currency to run on.

★**Bolsa Negra mine,** of the Hochschild group, after a precarious ex-



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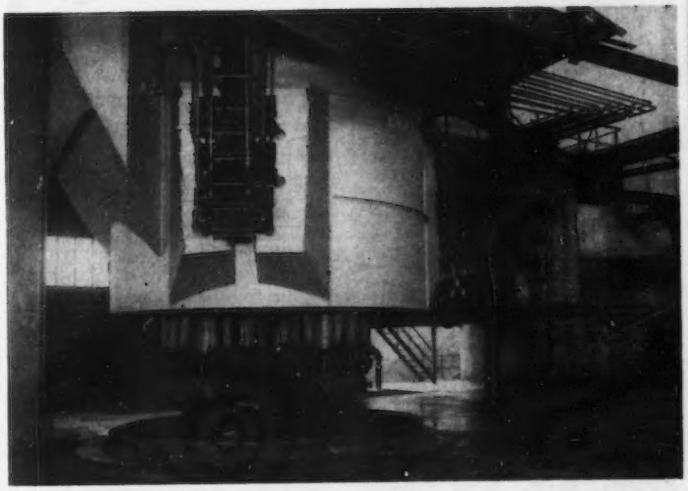

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Latin America *(Continued)*

istence for years, is now being mined actively. Production in 1951 thus far is about 1,000 short ton units of WO_3. Located in an offshoot of the Mururata Range, facing Illimani Peak, and only 42 miles from La Paz, the Bolsa Negra seems to be one of the most important known tungsten orebodies. It is estimated to contain about 25 million tons of ore running 0.32% WO_3.

★**The Bolivian government decreed in May a 30% increase for mining company employees, based on wages as of Dec. 1, 1950, the increase to be retroactive to April 1, 1951.**

BRAZIL

★**Presidential approval has been given a project to set up a plant to produce sulphur from a pyrite deposit in Santa Caterina state in southern Brazil, which is owned by the National Steelworks. Volta Redonda, the steel company, will put up half the needed capital and private investors will furnish the remainder. The move is part of Brazil's effort to alleviate the sulphur shortage, which has resulted in Brazil's imports of sulphur being cut from a needed 70,000 tons annually to about 45,000 tons.**

★**Volta Redonda has sent an engineer to study cassiterite deposits in Amapa Territory with the purpose of doing something to relieve Brazil's shortage of tin for tin-plate.**

★**A deposit of iron ore has been discovered in the Ribeira Valley about 200 km. southwest of Sao Paulo. The discovery was made by geologists of the Jaffet company, who estimate that the deposit contains "millions of tons" of high grade ore.**

★**About 1,500 tons of monazite concentrates is warehoused at the port of Victoria, most of which is reserved for Brazilian consumption or stockpiling. Working the deposits near Victoria in the state of Espiritu Santo, are two companies: Monazita e Ilmenita do Brasil and Foote Minerios Industrializados. The latter recently lost an attempt to block by injunction a government ruling that prohibits export of significant amounts of the concentrate to the United States.**

CHILE

★**Despite hours of conversation and the raising of the price charged abroad for Chilean copper, it is still not clear, in Chile at least, as to who will pay the extra 3 cents added to the copper price by agreement between Chile and the U. S. State Department. The Chilean Government is clear on one point, however, the added 3 cents is to go into the Treasury. On a yearly production of 880 million lb., this means $26.5 million. Chile can also dispose, presumably at good prices, of 20% of the American companies' output. The country itself consumes about 53,000 short tons yearly.**

★**Cia. Minera Aysen, lead-zinc producer in southern Chile, is building a hydroelectric power plant, the cost of diesel fuel at its remote location having proven too great to be carried.**

★**Cia. Minera Tocopilla, a steady producer for over 30 yr., is now mining about 700 tons of 17% copper ore per month from newly-acquired claims. Tocopilla is also producing 350 tons a month of 28% copper concentrate at its mill located at the port of Tocopilla.**

★**Because of higher copper prices and the scheduled opening of the new Paipote copper smelter next September, Caja de Credito Minero has given Chilean miners the best schedules yet offered, amounting to 4,300 pesos ($50) per metric ton of 10% copper ore, with a scale up or down of 615 pesos ($7.25) per unit.**

★**Cia. Minera Maipo, a new small producer which buys ores from other small mines in the Rancagua area, is building a 25-ton cyanide mill at Nos, a railroad depot near Santiago. The same company operates a flotation mill at Nos and a large plant for producing ferromanganese from ores of the Corral Quemada mines near Co-**

uimbo. These ores are smelted in electric furnaces.

★**Cia. Minera Merceditas** is increasing mill capacity from 100 tons a day to 280 tons daily through installation of a 7x6-ft. Traylor ball mill and more flotation machines. Grade of ore is 2.5% copper.

★**Cia. Minera Bellavista**, for years a gold producer, has been developing some low-grade zinc ore-shoots in its gold orebodies. The company plans a flotation plant.

★**The Farellon Sanchez** 120-ton copper mill at Matancilla in southern Coquimbo province, has overcome early milling difficulties and is now producing a 28% copper concentrate which also carries 0.33 oz. gold per ton.

★**Gold producers** have signed an agreement with the **Caja de Credito Minero** to sell all their output through the Caja, and thereby obtain 135 pesos per oz. for the next six months. The fixed price of gold is 85 pesos. The 50-peso bonus is to balance rising costs and encourage increased production of gold. Actually the bonus is paid, not by the government but by consumers who pay heavily to import automobiles and other luxuries.

MEXICO

★**Mexican mining paid dearly** for the labor peace it has bought for the next two years. Jesus Carrasco R., leader of the Mexican Miners' Union, estimates that the wage increases that averted the recent threat of a general strike of miners cost companies somewhere around $17,340,000 in direct wage increases and fringe benefits.

★**Mexico exported** an average of nearly a metric ton of gold monthly from 1946 through 1950, according to figures furnished by the Ministry of National Economy. The Bank of Mexico is the exclusive legal shipper.

★**A $5-million expansion** of the Altos Hornos steel mill at Monclova, Coahuila, will get under way soon. Made possible by a loan from the Export-Import Bank, the expansion will increase finishing capacity of the plant from 115,000 tons annually to 185,000 tons.

★**The 4,000 workers** in the **Monterrey Iron & Steel Works** who went on strike May 3 returned to work after 9 days off. They accepted an 8% wage increase, plus other benefits. Company losses for the 9-day strike are estimated at about $400,000, including damage to one furnace that was allowed to cool.

★**A new lead-zinc custom mill** is being built at Zimpan, 100 miles north of Mexico City by McCarthy and Christian. It is reported near completion.

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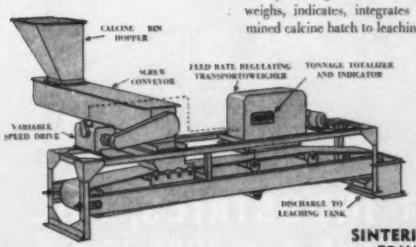

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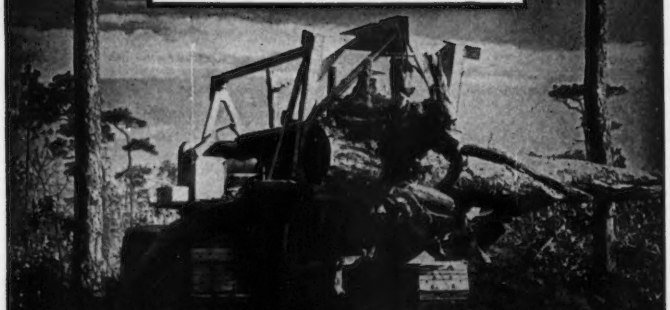

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IN INDIA

★**Zinc concentrates** are being exported from India for the first time in the country's history. The first shipment of 930 tons, running about 50% zinc, left India recently for Rotterdam. The ore is mined near Zawar, near Udaipur, by an Indian firm. There is no smelter in India, and all the country's annual requirements of 45,000 tons of zinc have to be imported.

★**The Rajasthan government** is shortly to undertake a program of systematic development of the mineral resources of the States Union, according to Mr. Munshi Lal Sethi, the Union's director of mines and geology. The general policy will be to give technical assistance to companies in finding, producing and manufacturing mineral products.

★**The United States imported** 530,885 tons of manganese ore, 1,767 tons of chrome ore, 11,167 tons of kyanite ore, and 35,227 tons of ilmenite ore in 1950. In giving these figures to the Indian Parliament, H. K. Mahatab, minister of industry and commerce, said that about one million tons of high grade manganese ore will be available this year, and an unlimited quantity of low grade ore. The embargo on export of monazite sands continues.

★India seems headed for **a boom year in gold smuggling,** with the price of gold in the Bombay free market running almost 50% above any other market in the world. According to one estimate, about $75 million worth of gold is smuggled into India each year.

IN THE PHILIPPINES

★**Gold miners** in the Philippines are in the odd position of having to ask the government to help break the law in order to keep them solvent. The present regulations on sale of gold require mining companies to sell 25% of their production to the Central Bank for $35 an oz. The rest of the gold has been sold on the Manila free market for prices that have at times gone up to $80 an oz. This free market gold is believed to be passing into the hands of Chinese buyers on the mainland, presumably Communist agents. In April, the Philippine government launched a drive to stop illegal export of gold. So succesful was this drive that during May only about 800 oz. of gold was sold on the free market, compared with a normal monthly sale of about 18,000 oz. The mining companies have no alternative but to sell their output to the Central Bank at the $35 price, which is below production costs for most mines. As this was written, the

mining men were considering a petition to President Quirino asking him to call off the police just enough to let the mining companies get back into the black.

★Gold production in April for **Benguet Consolidated** had a value of $284,168 at the statutory price, while **Balatoc** production came to $271,860. The mill treated 72,170 tons from both mines during the month, with an average recovered value of $7.80 per ton. This is an improvement over the average value of $7.53 per ton in 1950 from milling 727,037 tons, according to the annual report. The milling rate in April was 2,400 tons a day, a 25% increase over a year ago. However, operating costs show little reduction. In 1950 the cost per ounce of gold produced averaged $37.70 for Benguet and $38.10 for Balatoc. If it had not been for the premium prices paid for gold, which averaged $50.82 per ounce last year, both mines would have operated at a loss. Ore reserves have been well maintained and amounted to 4,289,000 tons valued in excess of $40,241,000 at the statutory price on January 1, 1951. The company bought a helicopter in 1950 which has been in operation for 6 months delivering payrolls to the various camps and transferring bullion from the mill to Manila. Because of the Huk activities in Mountain province and elsewhere the helicopter is probably good insurance against holdups.

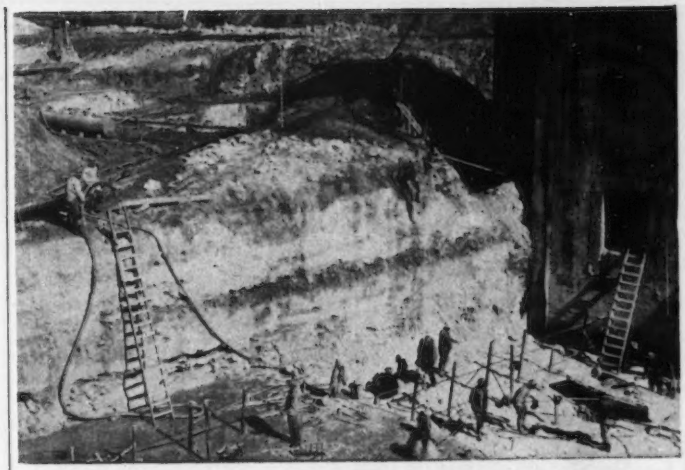
★Production of **Atok Big Wedge** in April continued to slide, with $136,000 recovered from milling 13,170 tons, an average of $10.30 per ton, compared with a monthly average in 1950 of $161,500. **Mandanao Mother Lode** held up well with $181,300 recovered from milling 10,000 tons durduring the month, and **Surigao Consolidated** had a higher output with $137,800.

★**Amalgamated Minerals**, operating a manganese deposit in Busuanga, shipped 1,438 tons of high-grade ore to Philipps Brothers in New York in April. Another shipment will be ready in June. The **Luzon Stevedoring Co.** has taken over operations of the **Palawan Mining Co.** in Busuanga and a large output is expected from this prominent pre-war producer. About 2,000 tons a month is being shipped from Bohol, at present the most important manganese producing area in the Philippines. High prices currently being paid for manganese ore have stimulated mining, and production in 1951 will undoubtedly be much larger than last year.

★**Samar Mining Co.** shipped 40,000 tons of high-grade iron ore to Japan in April. The **Philippine Iron Co.** increased its scale of operations. Work was resumed at Marinduque on the old **Gold Star** iron mine and 10,000 tons were sent to Japan.

★**A sharp demand for sulphur** for fertilizer and other purposes has caused renewed interest in the Kalinga deposits in Mountain province. These fumaroles were of exceptional purity but because of inaccessibility and high transportatin costs have not been exploited, except for laboratory purposes by chemists at some of the nearby gold mines. Pyrite deposits at Hixbar and Antigue are also being explored.

★**Lepanto Consolidated** produced 4,531 tons of concentrates in April containing 23.5% copper and 0.8 oz. gold per ton. Estimated smelter return for the month was $503,800 after smelter deductions and costs. Ore treated amounted to 28,013 tons averaging 4% copper and 0.15 oz. gold per ton.



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HERB J. HAWTHORNE INC.

P. O. BOX 7566, HOUSTON 8, TEXAS

2607

IN AUSTRALIA

★**Complaints** that the British government is buying base metals from foreign sources at ever-increasing premiums while Empire producers receive only the equivalent of the U. S. market price were voiced by Mr. John R. Govett, chairman of **Consolidated Zinc Corp.** and **New Broken Hill Cons.**, in a statement sent out to stockholders with the accounts and report for 1950. He said that if this practice should become a custom rather than the exception, there would be good cause for Commonwealth producers to ask for

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Australia *(Continued)*

at least equal treatment, to which they were entitled under the Ottawa Agreement.

★**Zinc Corporation** produced 433,325 tons of ore in 1950, compared with 488,830 tons in the preceding year. The mill treated a total of 599,010 tons, 64,970 tons less than in 1949. These figures include ore mined by New Broken Hill Cons. Completion of the fourth flotation section and fifth grinding section resulted in improvements in the recovery of lead and zinc. Underground development continued satisfactorily and the blocked-out ore reserves at the end of the year amounted to 5,100,000 tons of lead lode (an increase of 200,000 tons) and 450,000 tons of zinc lode (the same as 1949). Grades remained almost identical with 15.4% lead, 10.8% zinc and 1.4 oz. of silver.

NORTHERN TERRITORY

★Miners are reported to be deserting the **Tennant Creek gold field** for the **Mount Doreen wolfram workings**, 400 miles away. The exodus is partly in protest against increased charges by the government battery and partly induced by reports of fabulous prices paid for wolfram. Tennant Creek miners had been getting ordinary mine ore treated at prospecting concession rates. Only bona fide prospectors are now to have the advantage of the reduced treatment rate. The Mount Doreen field produced 136 tons of wolfram between 1935 and 1948. The deposits include alluvial and detrital material as well as pegmatites, quartz reefs and micaceous seams of varying dimensions in micaeous schist. Some of the miners are reported earning up to $450 a day.

WESTERN AUSTRALIA

★The view that **Norseman** would become a second Kalgoorlie was expressed by the Under-Secretary for Mines, Mr. A. H. Telfer. He said that he based his optimistic view on the work he had seen done at the Princess Royal mines of **Central Norseman Gold Corp.**, and on his knowledge of the company's program and results. Central Norseman is currently spending £300,000 on Princess Royal.

★**Norseman Gold Mines**, though still concentrating on pyrites production, remains interested in the gold possibilities of the field. The company intends to carry out an intensive diamond drill program to explore a suspected repetitional ore zone in the field.

★**New Coolgardie Gold Mines** milled 41,127 tons for 20,189 oz. in the year ended March 27. From the commencement of milling to the close of ac-

Nicholson Air Traps Assure
Positive Drainage
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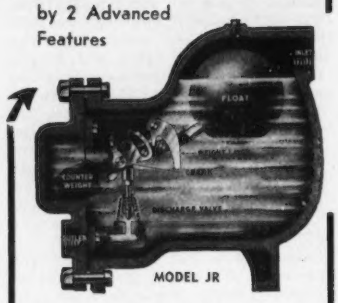
by 2 Advanced
Features



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counts in the previous year 31,766 tons were handled for a return of 13,375 oz.

★In the same period, **Gold Mines of Kalgoorlie** crushed 163,108 tons for 42,560 oz. compared with 163,213 tons and 41,357 oz. in 1949-50.

★**Kalgoorlie Southern Gold Mines** reports that a diamond drill hole has been advanced to 2,673 ft. and has been in quartz dolerite greenstone from 2,399 ft. to 2,673 ft. Quartz dolerite is the main productive rock in Kalgoorlie. The company was formed in February with the support of powerful gold and lead-zinc-silver mines. It is investigating the possibility of a repetition of the Kalgoorlie system to the south along the line of the Kalgoorlie anticline.

VICTORIA

★**Central Victoria Dredging Co.** hopes to have electric power available to operate a second dredge at Amphitheatre before the middle of the year. The company's other dredge, the Jim Crow, treated 1,603,440 cu. yd. in the year ended March 31 for a recovery of 6,393 oz. Each of the two dredges has a capacity of 2 million cu. yd. a year.

★**Hydraulic stowing of sand** has been adopted by **Wattle Gully Gold Mines** in stope filling. This has proved quicker, more reliable and considerably cheaper than dry filling or the "slurrying" method previously in use.

TASMANIA

★**King Island Scheelite (1947)** has installed a separate vanner plant to re-treat low-grade flotation concentrate at an estimated yield of 100 units WO_3 per week. A vanner plant for primary treatment has been in operation for some time. A new 8 ft. x 6 ft. ball mill is ready for installation.

★**Electrolytic Zinc Co. of Australasia** has been forced to reduce output at Risdon because of shipping holdups, which have curtailed supplies of concentrates from Port Pirie, and electric power shortages. Production for January-March was 19,400 tons, compared with 21,360 tons in the first quarter of 1950.

IN AFRICA

★**Diamond Distributors, Inc.**, New York, N. Y., turned over to the U. S. Government on June 17 industrial diamonds valued at $43,851.51 produced by the company's French associates, **Cie. Miniere de l'Oubanghi Oriental.** This shipment constituted the first repayment of advances made by the Economic Cooperation Administration to the French company for development of industrial diamond production in the Oubanghi territory of French Equatorial Africa. ECA advanced the equivalent of $2,650,000 to the French company for purchase of equipment and for exploration leading to increased production of diamonds. The advance is to be repaid in diamonds for the U. S. stockpile.

★Contracts have been entered into for sale of 25,000 short tons of antimony concentrates by **Consolidated Murchison Co.**, South Africa's major antimony producer, during 1951. Sales in 1950 totaled 13,440 tons. The increase is due to increased milling capacity to 15,000 tons a month, and to the discovery of a rich deposit yielding 95% payability over 3,080 ft. of development, averaging 14% antimony over a width of 81 in.

★In addition to the shaft being sunk at the fastest rate in the world (**Virginia Gold Mines**), the Orange Free State also has the largest shafts now being sunk anywhere. These shafts are on **Freddies North and South** properties and measure 47 x 11 ft. inside the concrete lining. Each has a ventilation compartment, 14 x 11 ft., separated from the rest of the shaft by a concrete wall extending the full depth of the shaft. There are 4 hoisting compartments and one more compartment for pump lines, ladderways and the service hoist. The shafts are now

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One of six, 4-ton, 24-inch gauge "Ranger" storage battery locomotives operating at the Resurrection Mining Company, Leadville, Colorado. This locomotive can be built with either single or two motor drive.

Cut your hauling costs with Greensburg Storage Battery Locomotives. Operators everywhere say our locomotives are 20% more efficient than any other storage battery locomotive.

If you are interested in haulage equipment, our strong, rugged, simple design, with double equalizers, glass insulated motors and longer battery life should be investigated!

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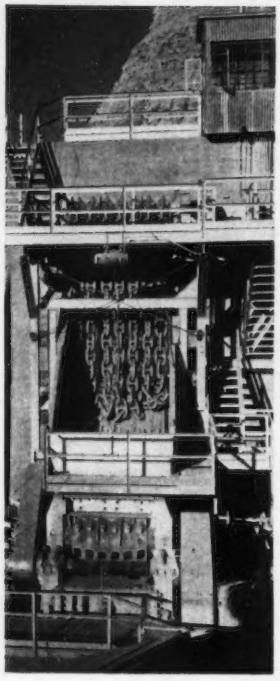
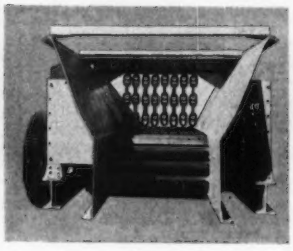
Ross FEEDERS

For Handling Rock Ores, etc.



Ross Chain Feeder



Ross Drop-Bar Grizzley Feeder

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Africa *(Continued)*

approaching 5,000 ft. in depth. Basal Reef will be intersected at 5,500 to 5,700 ft.

★ECA has agreed to advance up to $1,303,500 in French francs to the Soc. Miniere Intercoloniale to develop its diamond properties in French Equatorial Africa. This is the fourth in a series of such investments that will extend American financial aid to all the major producers of the area. The fifth, and final, such agreement is expected soon. The company has produced about 25% of the diamonds mined in the area since 1938. The first return on ECA's investment in this area's diamond mines has already been made, as described in the first item in this section.

What Kind of Compressor Plant

(Continued from page 145)

However, in a large mine it may be possible to have two or more plants large enough to be mechanically efficient and expertly handled and still have the benefit of shorter lines. Or if a management, for one reason or another, can't control leaks or provide adequate line capacity, they may get better results with dispersed compression. If there is temporary work to be done in extensive workings, the portable or semi-portable compressor eliminates laying long lines for short service life.

There is a place for every type, and only sizing up alternatives for each situation according to basic criteria will find the right solution. These are:

1. Initial cost, amortization and salvage.
2. Cost of assuring proper handling (casual handling doesn't pay under any circumstances).
3. Proper air and water supply.
4. Mechanical efficiency.
5. Feasibility of efficiency-producing accessories, such as automatic controls, coolers and receivers.
6. Friction losses in lines and connections.
7. Maximum use of investment (such as around-the-clock operation, or avoidance of unnecessary total standby capacity).
8. Kinds and costs of alternative types of power to drive compressors.
9. Cost and maintenance of lines and receivers.
10. Adaptability to minimize production stoppages or slowdowns.
11. Maintenance cost.
12. Ability of management to attend to details.

HINGED PLATEGRIP

BELT FASTENER No. 500

FOR HEAVY CONVEYOR BELTS OF CHANGING LENGTH

These heavy-duty belt fasteners make a strong, flexible joint in conveyor belts, belts of any width and of from 3/8" to 1/2" thickness. They offer special advantages in mines, quarries or industrial setups where length or position of belt is frequently changed, because sections can be removed or added at will. Joints are opened for this purpose by simply pulling out the hinge pin.

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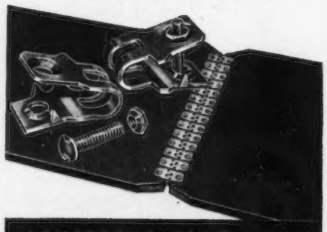
Write for Circular.



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Yes, weigh and record with the —MERRICK

WEIGHTOMETER

The Merrick Weightometer provides a continuous, automatic, accurate weight record at any designated point in the mill, while material is in motion on conveyor. It weighs without interrupting conveyor service.

Applicable to any size belt conveyor, horizontal or inclined. An accurate and dependable means of keeping constant check on production.

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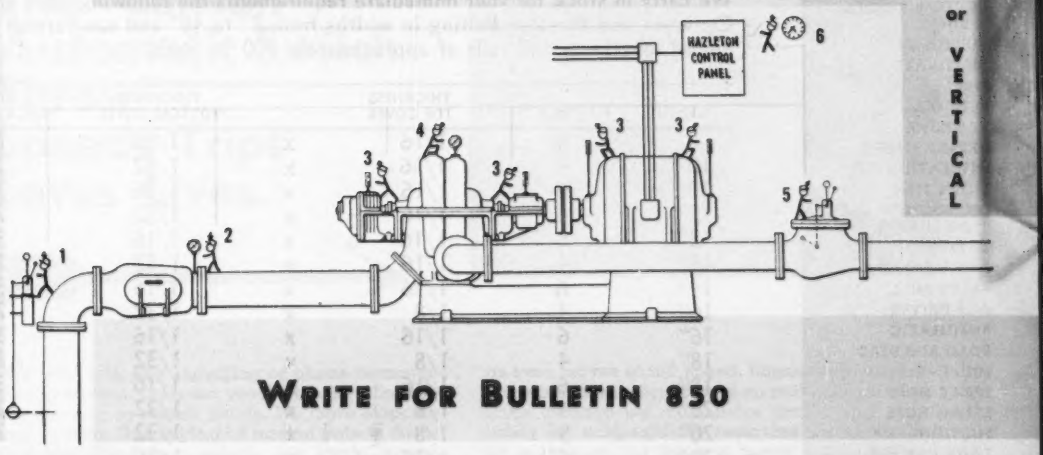
AUTOMATIC PUMP-CONTROL

PROVIDES:

1. SUMP LEVEL CONTROL—START, STOP, HIGH WATER ALARM.
2. PROTECTION AGAINST EXCESSIVE SUCTION LIFT—BLOCKED STRAINER.
3. PROTECTION AGAINST OVERHEATED PUMP AND MOTOR BEARINGS.
4. PROTECTION AGAINST COLUMN LINE FAILURE—LOSS OF PUMPING HEAD.
5. PROTECTION AGAINST LOSS OF WATER—BROKEN SHAFT, AIR LEAK.
6. LIMITED PRIMING TIME AND NUMBER OF STARTS; DELAYED START; TIME CLOCK CONTROL FOR "OFF-PEAK" PUMPING.

CONTROL FOR ANY INSTALLATION—HORIZONTAL or VERTICAL



WRITE FOR BULLETIN 850

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  - SAFETY GRIP
  - TRANSMISSION
  - "V" BELTS
- HOSE
  - ACETYLENE
  - AIR
  - BREWERS and BEVERAGE
  - CAR WASHING
  - CHEMICAL
  - COTTON RUBBER LINED
  - DISCHARGE
  - DISTILLATE
  - FIRE
  - FUEL OIL
  - GASOLINE
  - GREASE PUMP
  - INSULATION
  - LINEN FIRE
  - OIL: SUCTION and DISCHARGE
  - OXYGEN
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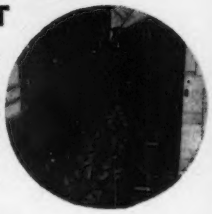
Rubber Conveyor a nd Elevator Belting

Why wait — We have EIGHT to FORTY EIGHT



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STRONG CARCASS — Constructed of finest quality 28 and 32 ounce tough cotton duck, properly treated and impregnated to avoid mildew from moisture and atmospheric conditions. Each ply thoroughly embedded in rubber to prevent ply separation, having a 16-19 lb. average friction pull.

FLEXIBILITY — Careful attention has been given in the construction of all belts to have the proper flexibility assuring the following desirable features: troughs easily, runs true on all idlers, gouge resistant, excellent for long and short hauls and slope installations.

All our belting made by the leading belting manufacturers.

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WIDTH	PLY	THICKNESS TOP COVER		THICKNESS BOTTOM COVER	TYPE OF DUCK CARCASS
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10″	4	1/16	x	1/32	28 oz.
10″	6	1/16	x	1/16	32 oz.
12″	4	1/16	x	1/32	28 oz.
12″	6	1/16	x	1/16	32 oz.
14″	4	1/16	x	1/32	28 oz.
14″	6	1/16	x	1/16	32 oz.
16″	4	1/8	x	1/32	28 oz.
16″	6	1/16	x	1/16	32 oz.
18″	4	1/8	x	1/32	28 oz.
18″	6	1/16	x	1/16	32 oz.
20″	4	1/8	x	1/32	28 oz.
20″	5	1/8	x	1/32	28 oz.
20″	6	1/16	x	1/16	32 oz.
24″	4	1/8	x	1/32	28 oz.
24″	5	1/8	x	1/32	28 oz.
26″	5	1/8	x	1/32	28 oz.
30″	4	1/8	x	1/16	32 oz.
30″	5	1/8	x	1/16	32 oz.
30″	6	1/8	x	1/16	32 oz.
36″	6	1/8	x	1/16	32 oz.
42″	5	1/8	x	1/16	32 oz.
48″	8	1/8	x	1/16	32 oz.

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Works with any signalling or phone communicating system. Increase production by eliminating the stop at switch points. No more stopping and starting. No jumping off and on train to throw switches. Motorman selects his track, switch points are thrown to desired route by motorman as train moves at full speed. Eliminating the stop increases production. Speed-up makes more trips, more tonnage per day, more profits. Increases safety by automatically removing the necessity for a man on the track to throw switch points. No man . . . no accidents.

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Only with the help of the refractory industry could steel have achieved its fabulous progress. Only with the development of better and more diversified refractories and adequate production could steel deliver today's tonnage.

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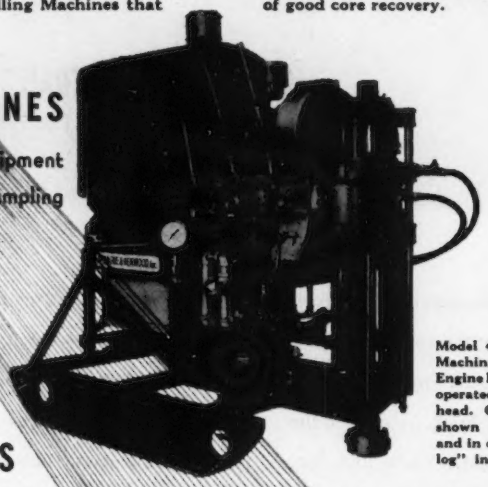
and Complete Accessory Equipment for Core Drilling and Dry Sampling



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have proved their superiority for years in all types of rock formation. Set with any desired grade of bortz diamonds in a matrix of either copper or nickel alloy and available in a wide variety of standard and special types and sizes, ranging from 1-1/2" to 7-3/4" in diameter. Write for Bulletin No. 44-A.

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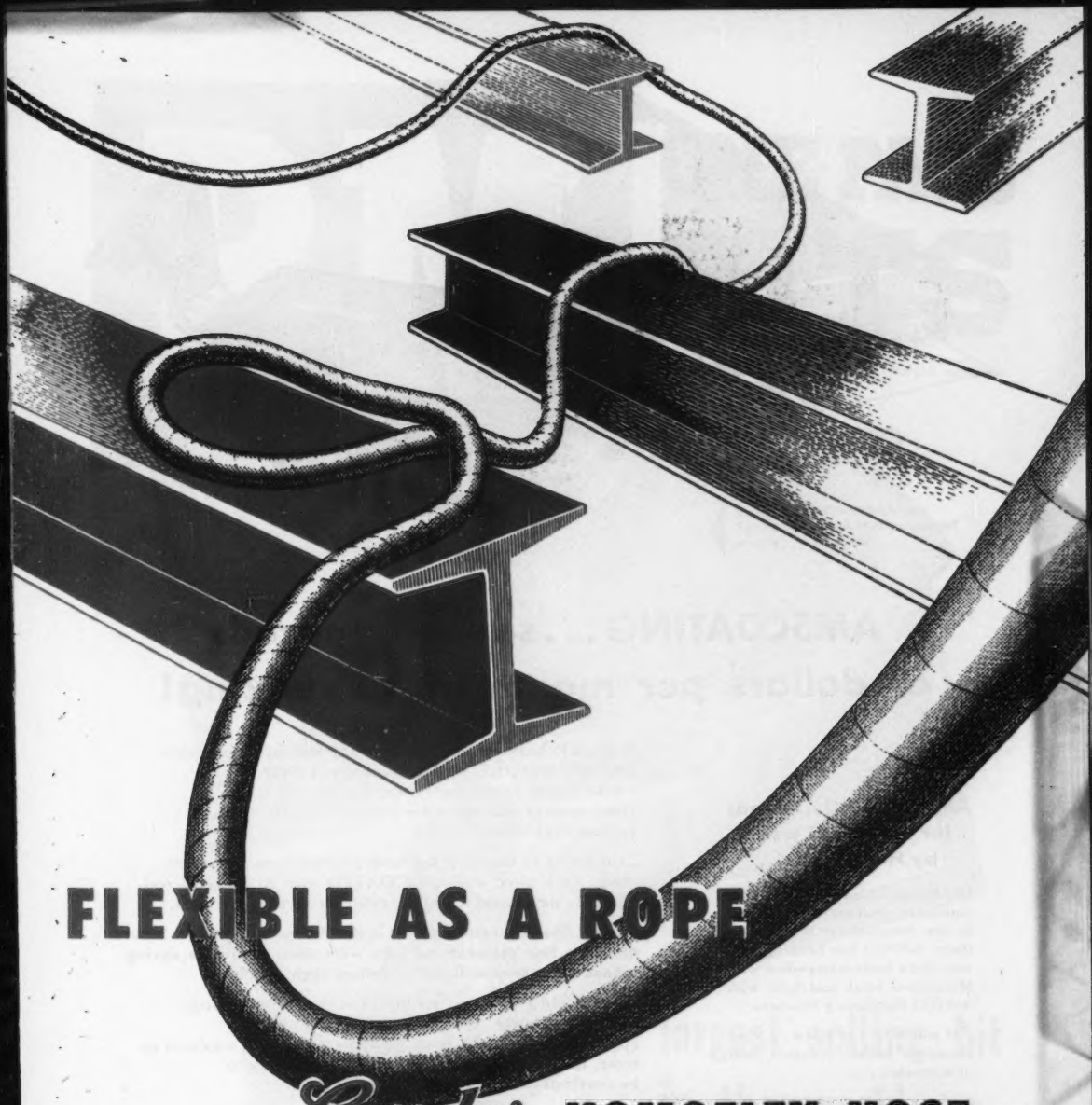

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AMSCOATING . . . saves hundreds of dollars per month in pulverizing!

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Hardfacing rods—and recommendations for their use—are as sound as the manufacturer who makes them. AMSCO has been fighting wear for a half-century—first with Manganese Steel, and later with AMSCO Hardfacing Products.

If you have a problem of wear caused by impact, abrasion, heat or corrosion . . .

Find out how AMSCOATING can save you materials . . . manpower . . . money!

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In trying to stop this high replacement cost, a test was made. Each plow was AMSCOATED with an Amsco® rod specially developed for high resistance to abrasive wear.

Result? The Amscoated plows lasted 4 times as long . . . 3 out of every four replacement jobs were eliminated! The saving amounted to several hundred dollars each month!

AMSCOATING permits big savings—through longer service and fewer replacements—on many other applications. If you have an equipment part that's subject to wear, the possible savings—*to you*—are too big to be overlooked!

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largest selling bit in the world . . .

Hayes

This is the bit with the simplest possible type of connection. It depends on a differential angle between the skirt on the bit and the angle of taper on the shank, coupled with an accurate ratio between the depth of socket and its diameter. Three other features — Flattened Points — Offset Gauge — Thinner Wings, contribute to the faster, lower cost operation of the Hayes P & M bit. Used in 26 countries — 50 million a year in one country alone, the P & M bit is one you should try. *Write for Bulletin 741.*

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Completely resistant to the chemical action of surphurous waters, alkalies, metallic salts, and other corrosive wastes, CARLON solves piping problems in surface and subsurface mining operations. This durable new pipe is **guaranteed** against rot, rust, and electrolytic corrosion, and it has a service life many times longer than ordinary pipe.

Lightweight CARLON plastic pipe does not require materials handling equipment or special tools for rapid installation. Recommended applications for this pipe are drinking water and drainage systems, ventilating lines, hydraulic sluicing, intake and exhaust piping, dredge discharge lines, low-pressure air lines, etc.

Both flexible and rigid types of CARLON are available in standard pipe sizes. Flexible pipe is furnished in long lengths which conform to irregular surface contours or ditch lines and require fewer fittings per installation. Rigid CARLON is shipped in threaded and coupled random 21-foot lengths which can be joined quickly by means of threaded plastic fittings. To meet individual job requirements, rigid CARLON can be cut to desired lengths and threaded with standard pipe dies.

Specify ONLY CARLON to obtain the most versatile mine pipe available today.

At present, raw material shortages are limiting the production of certain types of CARLON pipe. Every effort is being made, however, to overcome this problem and to meet the demand and need for CARLON... the first real pipe that is plastic!

CARLON CP 186-CP

CARLON PRODUCTS CORPORATION

IN CANADA: MICRO PLASTICS, LTD., ACTON, ONTARIO

10220 MEECH AVENUE • CLEVELAND 5, OHIO

GOULD

Plus-Performance Plan

. . . TELLS YOU HOW TO

SELECT YOUR BATTERIES TO FIT YOUR JOB!

You can increase battery performance as much as 50% through the help of the GOULD PLUS-PERFORMANCE PLAN! Here is a complete and integrated system of manuals, articles, specifications, bulletins, record cards, and charts which explain and illustrate how to select, charge and handle, maintain, and determine the condition of your batteries. Designed to help you conserve and extend your essential battery power the GOULD PLUS-PERFORMANCE PLAN is FREE to ALL battery users, without obligation. A request on your letterhead, will bring book describing the plan by return mail.

AN EXAMPLE OF PLUS-PERFORMANCE PLAN HELPFULNESS

How To Select Mining Batteries

FOR SHUTTLE CAR BATTERIES, selection is comparatively simple. A 13-plate, 330 AH battery is standard for low coal. Where height permits, an extra-high 9-plate, 400 AH battery can be used. For ore mines, 17-plate, 440 AH batteries are preferred.

FOR LOCOMOTIVES, selection is more complicated for it involves consideration of grade, weight and distance. The GOULD PLUS-PERFORMANCE PLAN includes a table showing the watt-hours needed to move one train-ton various distances over various grades, and full instructions on how this table can be used to determine the total watt-hours required per shift, the total cells necessary and the ampere-hour capacity required of the battery. These simple computations enable you to order exactly the size and type battery needed to do your job.

Gould "Thirty" with "Z" Plates— America's Finest Mining Battery

GOULD STORAGE BATTERIES

GOULD-NATIONAL BATTERIES, INC., TRENTON 7, NEW JERSEY

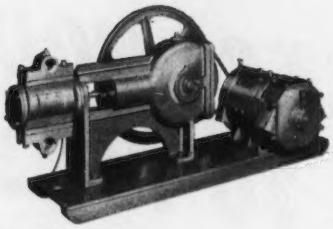
Always Use Gould-National Automobile and Truck Batteries

Solve Mine Drainage Problems with FLOOD CITY pumps

PORTABLE GATHERING PUMP

The Flood City Portable Gathering Pump is a sturdy, compact unit—light enough to be readily moved about the mine. Outstanding features include: Suction and discharge chambers that can be turned to meet existing pipe connections . . . crosshead moves in a cast iron sleeve that is readily removable . . . all moving parts are self-oiling and sealed against leakage and dirt . . . easily replaced valve seat plate, reversible for double life.

SPECIFICATIONS: Capacity, 20 gallons per minute; thoroughly guarded V-belt drive; total weight with 1 H. P. motor, 375#; Length, 42"; Height, 22"; Width, 17" over motor. Dimensions can be adjusted for individual conditions.



CENTRIFUGAL PUMP

Flood City also manufactures a complete line of Centrifugal Pumps for mines. The working parts are made of high quality acid-resisting bronze with standard ball-bearing pillow blocks that are readily replaceable. Casing rings are of tongue and groove construction that gives a permanent seal at all times. Pumps are designed and built to maintain top operating efficiency with a minimum of maintenance.

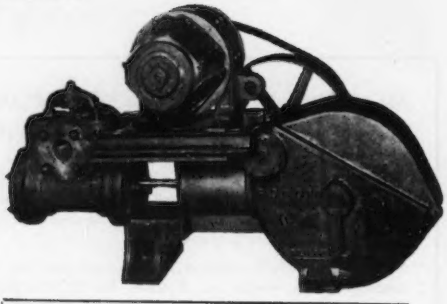
SPECIFICATIONS: Complete range of pumps includes capacities of 50 to 1000 gallons per minute. Individual specifications to meet your particular drainage problem will be furnished upon request.

PLUNGER PUMP

Flood City Plunger Pumps are heavily constructed of acid-resisting material—carefully finished to permit a free flow of water. Reversible water ends are incorporated in the pumps to assure ease of connection. All moving parts are self-lubricated . . . all parts are easily accessible for servicing when required . . . shielded piston rod keeps water off the power frame.

SPECIFICATIONS: 5 x 5 size; Capacity 50 gallons per minute; 2" Suction and 2" discharge. Write for complete information on this and other types of Flood City Pumps.

We also specialize in furnishing BRONZE REPLACEMENT PARTS . . . CAR-SPOTTING HOISTS . . . TROLLEY LINE MATERIAL. Your inquiries are invited.



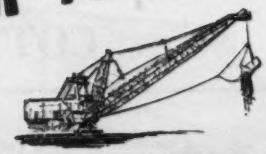
Write today for complete details and price information.

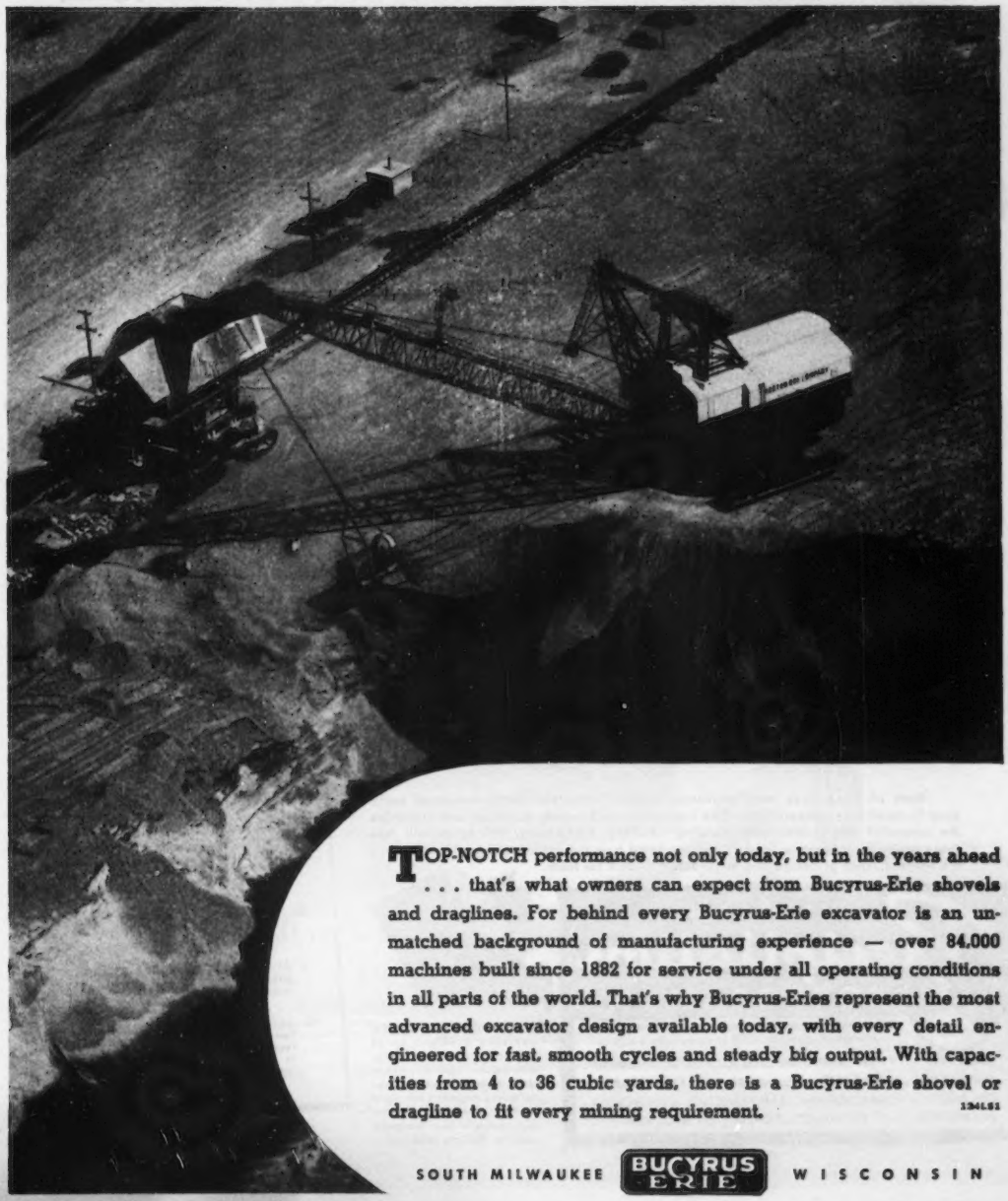
FLOOD CITY BRASS & ELECTRIC CO.

MESSENGER AND ELDER STS., JOHNSTOWN, PA.

BRANCH OFFICE — 4 VIRGINIA ST. • • CHARLESTON, WEST VIRGINIA

DESIGNED FOR TOMORROW





TOP-NOTCH performance not only today, but in the years ahead . . . that's what owners can expect from Bucyrus-Erie shovels and draglines. For behind every Bucyrus-Erie excavator is an unmatched background of manufacturing experience — over 84,000 machines built since 1882 for service under all operating conditions in all parts of the world. That's why Bucyrus-Eries represent the most advanced excavator design available today, with every detail engineered for fast, smooth cycles and steady big output. With capacities from 4 to 36 cubic yards, there is a Bucyrus-Erie shovel or dragline to fit every mining requirement.

134L81

SOUTH MILWAUKEE BUCYRUS-ERIE WISCONSIN

Important points to know about COTTRELL *Electrical Precipitators*

A COTTRELL Electrical Precipitator is a major plant investment. Once installed it is operated over a period of many years, *thus multiplying year after year the benefits of top notch design and installation.*

And because of the many factors affecting the operating and collecting efficiency of a COTTRELL Precipitator, probably in no other field do the experience and "know-how" of the organization designing and installing the unit play a more important role in influencing the overall performance of the installation. That is why it is so important to remember this fact . . .

▶ *Western Precipitation Corporation is the organization that installed the first successful* COTTRELL *Precipitator over 39 years ago, still operating efficiently . . . and has consistently developed new refinements, new techniques, new applications that today have made it world famous in the science of recovering dusts, fly ash, mists, fogs and other suspensions from gases.*

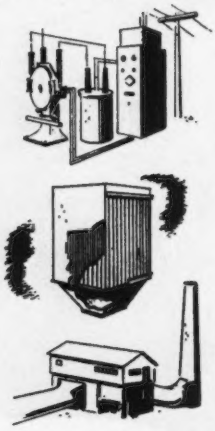
This is the first of a series of advertisements briefly outlining the important elements that go to make up a COTTRELL installation. Only long experience coupled with highest engineering ability, can assure the proper combination of these elements into a COTTRELL installation best suited to *your particular requirements*!

Basically, a Cottrell Precipitator consists of three major divisions each in turn consisting of many separate elements . . .

1. THE ENERGIZING SYSTEM, as its name implies, is the portion of the unit wherein the power is brought in, the voltage stepped up, then rectified to provide the unidirectional high voltage current supply for the Electrode System.

2. THE ELECTRODE SYSTEM consists of the high-tension ionizing electrodes and collecting electrodes through which the suspension-laden gas is passed to be cleaned. These electrodes can be of various designs, shapes and patterns and are equipped with various "rapper" arrangements which assist in keeping the electrodes clean of recovered materials.

3. THE HOUSING OR SHELL includes the structure containing the Electrode and Energizing Systems as well as the gas ducts and distributing system, the hoppers for receiving the collected material and other miscellaneous equipment.



Each of these three major divisions, together with their many individual parts, must be carefully engineered into ONE integrated and precisely-balanced unit to provide the successful and continuously-operating COTTRELL Precipitator. This series will take these major units apart to show in greater detail how the individual parts function and the varying types of design and construction. Watch for them.

10 COTTRELL ADVANTAGES

that make Cottrells unsurpassed for all types of recovery problems, hot or cold, wet or dry

1. LOWEST DRAFT LOSS — only a few tenths of an inch w. g.
2. LOWEST POWER COST — only ½ to 1 kwh. per 100,000 cu. ft. of gas cleaned.
3. LOWEST MAINTENANCE COST — all metal, few moving parts, no fire hazard.
4. LOWEST LABOR COST — operation can be fully automatic, if desired.
5. LONGEST LIFE — early Cottrell installations still operating after 39 years of continuous service.
6. HIGHEST EFFICIENCY — recovery efficiency approaches 100%, if desired.
7. UNIVERSAL APPLICABILITY — recover any suspension, solid or liquid — in any gas — over wide temperature ranges.
8. ANY CAPACITY — handle a few c.f.m. — or millions — with equal ease.
9. MAXIMUM FLEXIBILITY — readily adaptable to varying installation requirements.
10. LOWEST OVERALL COST — cost less per year of service, less per ton recovered. Often pay for themselves in a few months — always within a few years.

WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices 1012 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA
CHRYSLER BLDG., NEW YORK 17 • 1 LaSALLE ST. BLDG., 1 N. LaSALLE ST., CHICAGO 2 • HOBART BUILDING, SAN FRANCISCO 4, CALIFORNIA
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

Do You Have This Helpful COTTRELL Booklet? In 28 pages of interesting charts, illustrations and descriptive data, it answers many of the questions engineers ask about COTTRELL design and construction. Send for your free copy. Ask for Bulletin CB031

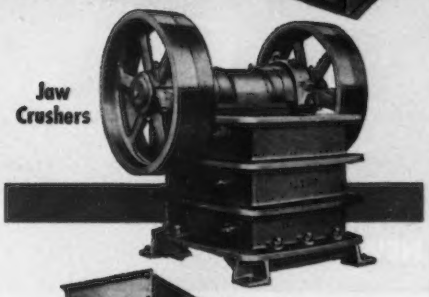
TELSMITH

feeding
coarse crushing
screening
fine crushing

EQUIPMENT FOR MINES

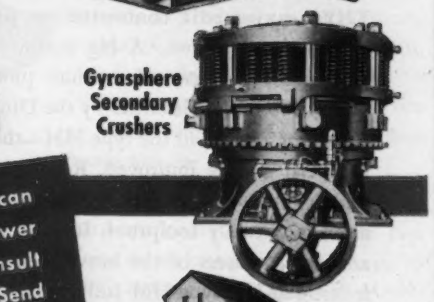
Heavy-Duty Feeders

Jaw Crushers



Vibrating Screens

Gyrasphere Secondary Crushers



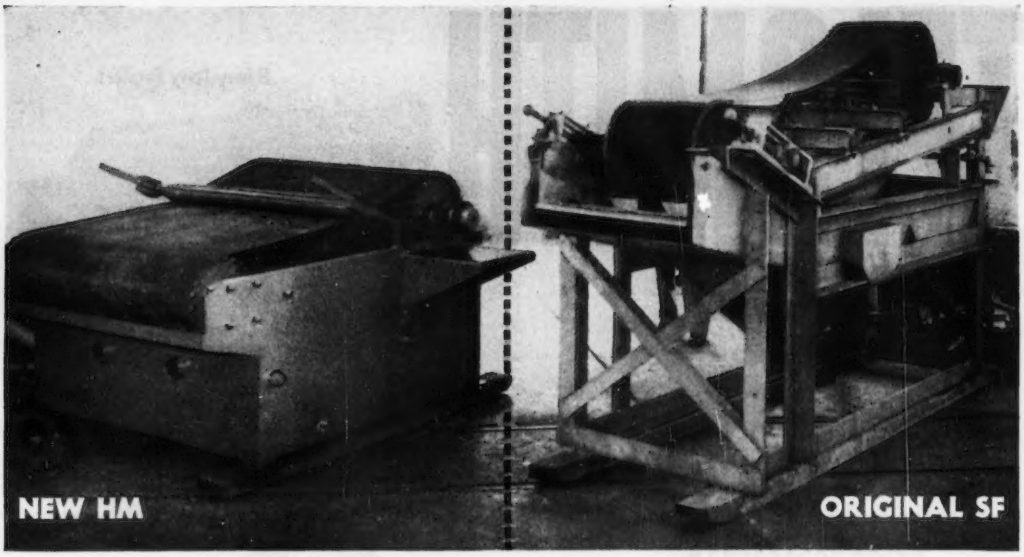
Find out HOW You can get Top Tonnage at Lower Cost Per Ton . . . Consult Telsmith Engineers. Send for Bulletin 266.

Min. 33

SMITH ENGINEERING WORKS, 502 EAST CAPITOL DRIVE, MILWAUKEE 12, WISCONSIN

Cable Address: Smigworks, Milwaukee

Schutal Osborn (S. A.) Ltd., Johannesburg, So. Africa • Arnoux Industrial Corp., Buenos Aires, Argentina
51 East 42nd St., New York 17, N. Y. • 211 W. Wacker Dr., Chicago 6, Ill. • Mayo Machinery Supply Co., Denver 17, Colo. • Jones Eng. & Equip. Co., San Francisco 6, Calif.
Ontario Equip. & Supply Ltd., Toronto, Canada • Hewitson Conveyor Ltd., Montreal, P. Q. • Cockshutt Farm Equip. Ltd., Vancouver, B. C.



Heavy Media Recovery Improved 9 Ways

DINGS TYPE HM CROCKETT SEPARATOR RECOVERS 99.8%, IS SMALLER, LIGHTER, COSTS LESS*

THE heavy media concentration process** is coming into its own. A big reason why is the economical recovery of medium pioneered and brought to peak efficiencies by the Dings Crockett Separator. Now—in the type HM—this separator has been greatly improved. Recoveries are even higher—99.89% in at least one case—and its operation is virtually foolproof. It will pay potential and current users of the heavy media process to investigate the type HM fully.

AIEE Paper on Heavy Media Process Available Free

Co-authored by K. A. Blind of Dings and J. J. Bean of American Cyanamid, this 9-pg. paper will be of considerable help to anyone interested in the potentials of the Heavy Media Process. Write:

DINGS MAGNETIC SEPARATOR COMPANY
4716 W. Electric Ave., Milwaukee 46, Wis.

IMPROVED FEATURES OF DINGS TYPE HM CROCKETT

1. Incorporates 6 magnet poles compared to 8. Purity of concentrate remains the same; recoveries are considerably improved.
2. New design permits lower cost.
3. Floor space reduced 53%; head room reduced 34 inches.
4. Magnetic intensity increased 15%.
5. New undershot feed arrangement provides greater medium recoveries.
6. Side overflows eliminated; this product now discharged adjacent to the tailings valve. No piping is needed.
7. Sealed self-aligning ball bearings on head and tail pulleys.
8. New self-adjusting belt tightener.
9. Integral tank and frame assembly permits standardization irrespective of head room requirements.

DINGS SEPARATORS HAVE BORNE AMERICAN CYANAMID COMPANY'S APPROVAL FOR OVER 10 YEARS.

Dings Magnets

*Dings Mag. Sepr. Co. is the only manufacturer licensed to build the Crockett Magnetic Separator.

**The Heavy Media Separation Processes are licensed by American Zinc, Lead and Smelting Co. American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y., are their sole technical and Sales Representatives for these processes.

Accept this Helping Hand in your Production for Defense!

Accent on PRODUCTION calls for heads up maintenance.

KYSOR'S long history of service to industry as producer of automatically controlled shutters for positive operating temperature control, equips it NOW to render exceptional service to many major industries in their *production for defense.*

KYSOR Shutters on diesel locomotives, stationary engines, trucks and buses mean longer engine life, up to 12% savings in fuel, LOWER MAINTENANCE COSTS . . . services that are always welcome, but *vital* now!

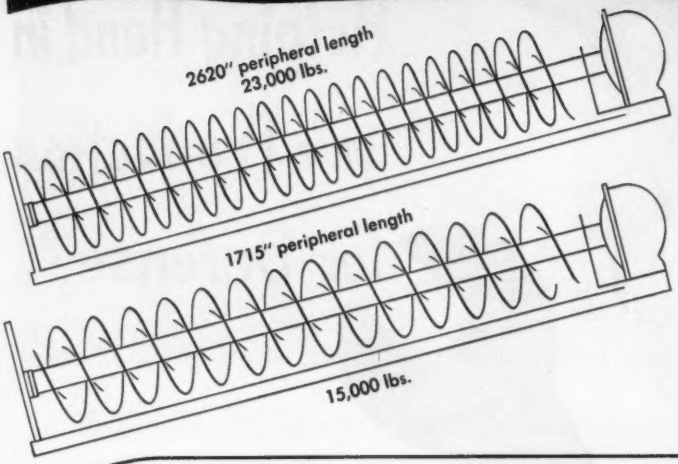
Inquiries invited. Write to:

KYSOR

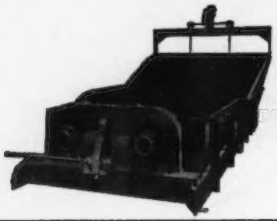
HEATER COMPANY

Cadillac, Michigan

AKINS classifiers have 50% more capacity



MORE FLIGHTS
(Conveying Surface)
Per Foot in Akins Construction



The Akins Classifier uses the tightest (shortest pitch) spiral offered for mineral beneficiation. Careful comparative tests* prove that the standard Akins spiral pitch (one-half the diameter) is more efficient than spirals with longer pitches.

Because there is more steel in an Akins spiral, the initial cost is a little more, but this is quickly returned by the profits made possible by dependable steady operation at rated capacity PLUS, or 150% of the longer pitch machine. Write for details of mechanical and metallurgical advantages of Akins design and construction.**

*A report of a technical investigation on the comparison of spiral capacities at different pitches is available. Ask for Technical Investigation No. 51.

**Ask for Bulletin No. 48 for closed circuit grinding, or No. 48-S for specialized applications that may solve your particular problem.

Licensed Manufacturing Representatives

Canadian Locomotive Co., Ltd.....Kingston, Ontario
Head, Wrightson & Co., Ltd.....Stockton on Tees, Eng.
John Carruthers & Co. (Pty.) Ltd.....Sydney, Australia
Head, Wrightson & Co., S.A., (Pty.) Ltd.....Johannesburg

Authorized Sales Agents

Edward J. Nell Co.....Manila, P.I.
Wright Bros., Credit Foncier Bldg.....Vancouver, B.C.

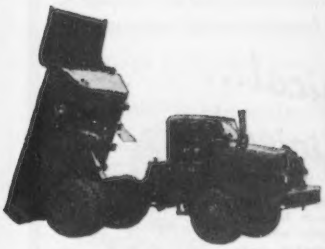
NO IMPORTANT AKINS INSTALLATION HAS EVER BEEN REPLACED BY ANY OTHER CLASSIFICATION EQUIPMENT

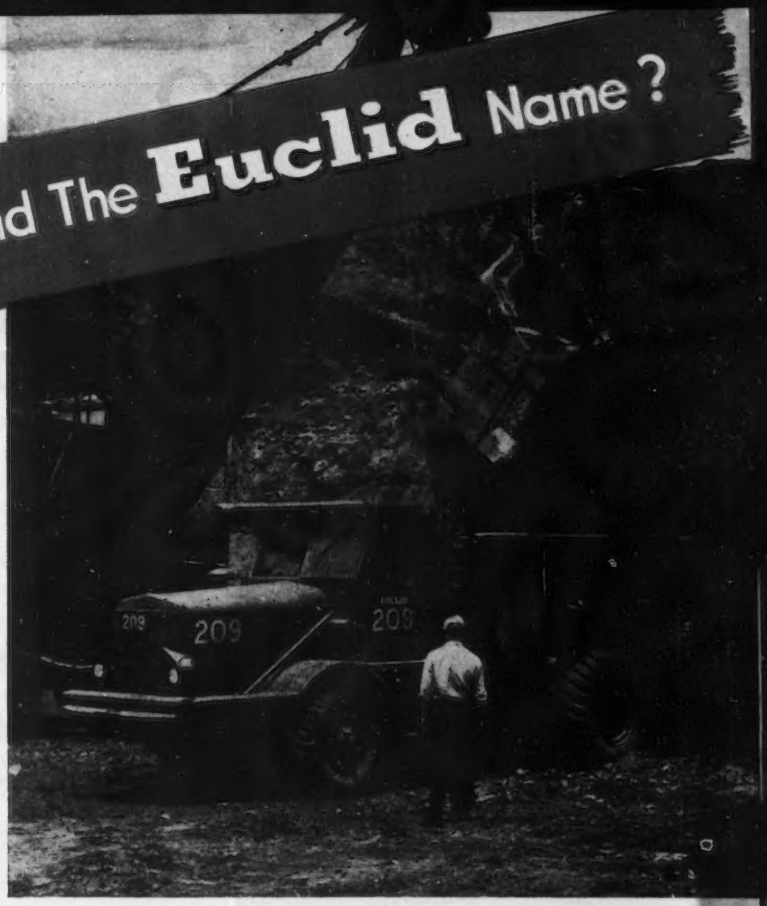
THE COLORADO IRON WORKS COMPANY
C I W

Colorado Iron Works Co.

1624 17TH STREET DENVER 2, COLO.

What's Behind The Euclid Name?





* Dependability

Euclids are engineered for the job . . . built for efficient, long life performance in off-the-highway service. In mines and quarries, on construction and industrial jobs, "Eucs" have earned their reputation for durability and low cost operation.

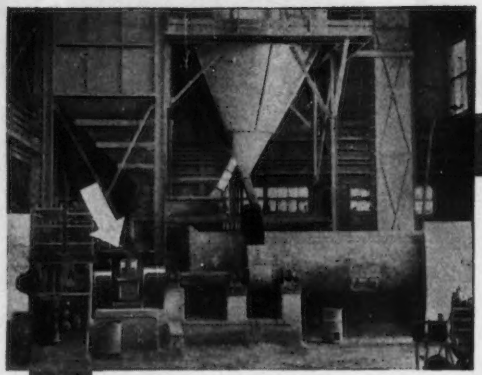
Plenty of power . . . large capacity for bigger loads . . . body designs for all types of materials . . . earth, ore, rock, or coal. Rear-Dump Euclids range in capacity from 10 to 34 tons, have diesel engines from 125 to 400 h.p. Bottom-Dump Euclids have capacities of 13 to 50 cu. yds., 20 to 40 tons with diesel engines to 300 h.p.

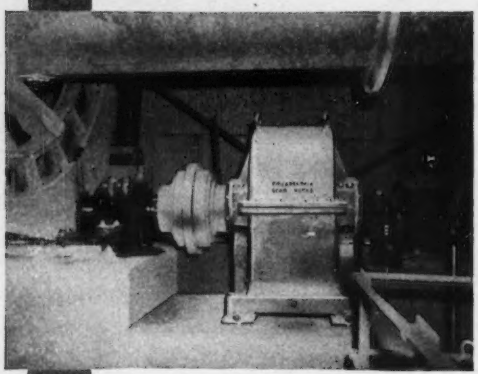
Repeat orders prove customer satisfaction. Owners say that "Eucs" actually cost less to own than any other hauling equipment. Euclid dependability will pay off on your present or future jobs. Write for complete information on the Euclid line, or call your distributor today.

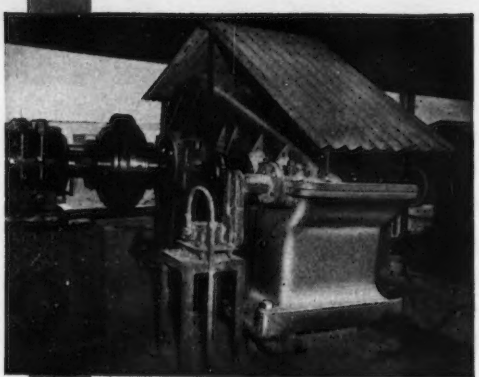
The EUCLID ROAD MACHINERY CO.,
CLEVELAND 17, OHIO

MORE LOADS PER HOUR—
MORE PROFIT PER LOAD

EUCLIDS *Move the Earth*







3 well known Cement Plants

choose

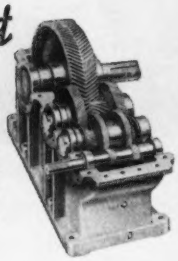
PHILADELPHIA HERRINGBONE SPEED REDUCERS

TOP A triple reduction Herringbone unit driving Kiln in a St. Louis Cement Plant.

CENTER A kiln drive of a Dallas plant operating through a triple reduction Philadelphia Herringbone Reducer.

LOWER A Houston plant drives this tube mill through a double reduction Philadelphia Herringbone unit.

Economical... Efficient



Philadelphia Herringbone Units are noted throughout industry for their long, highly efficient and trouble-free service, even under the most severe conditions—Single, double and triple reduction types with standard reduction ratios from 1.75 to 1 up to 320 to 1.

HOUSINGS

Housings are fully enclosed, compact and self-contained with absolute freedom from oil leakage. Liberally proportioned bearings permit external overhung loads on output and input shafts.

GEARS

Symmetrical arrangement of gears is a feature which produces equal loads on the bearings of each shaft and allows a more compact design.

LUBRICATION

Gears and bearings are lubricated by the same lubricant, and the ample sized oil reservoir insures cool operation.

For complete details—send for Catalog H-49—Please write on your Business Letterhead.

Philadelphia Gear Works, INC.

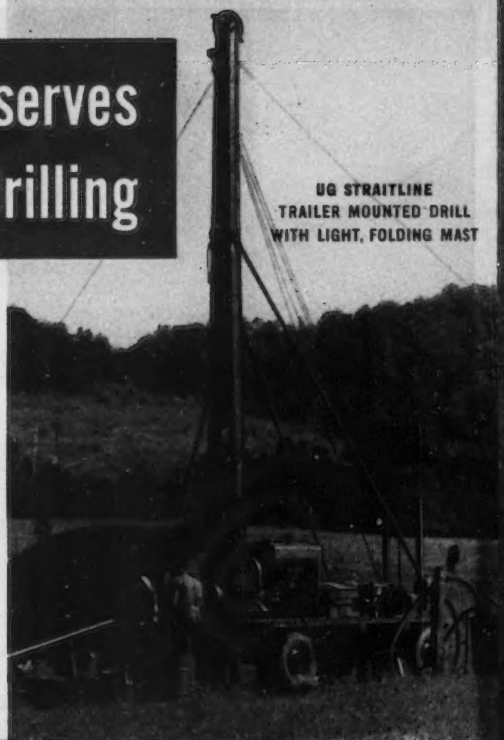
ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Increase Mineral Reserves By Diamond Core Drilling

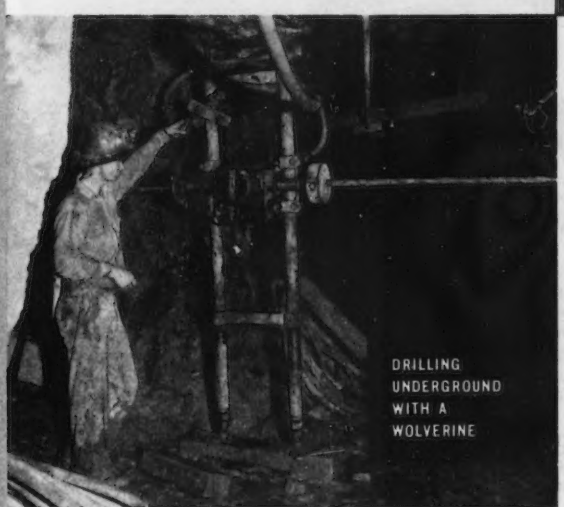


UG STRAITLINE TRAILER MOUNTED DRILL WITH LIGHT, FOLDING MAST

● Rich orebodies become worked out. Even reserves, once adequate, are dangerously low in many cases, yet the long term demand for minerals increases.

How is this challenge to be met? First of all, new deposits must and can be found by systematic exploratory search. Second, every effort should be made to expand present reserves.

The LONGYEAR organization will help you to accomplish the above objectives. It will supply you with drills suited to your job, or it will do your drilling under contract, if you prefer.



DRILLING UNDERGROUND WITH A WOLVERINE

CORE DRILLING ON CONTRACT. In contracting your drilling to **LONGYEAR**, you gain the following advantages:

WITHOUT INVESTMENT *on your part, modern LONGYEAR core drills and equipment are available for your drilling projects.*

EXPERIENCED CREWS, *using the latest drilling techniques, carry out your exploratory program in accord with your wishes.*

YOU ARE PROVIDED *with accurate samples, most essential factors in your mineral search.*

DIAMOND CORE DRILLS. LONGYEAR manufactures a complete line of diamond core drills and equipment.

LIGHTWEIGHT, *easily set up machines are built for underground use.*

STURDY, *mobile equipment is available for rapid surface exploration.*

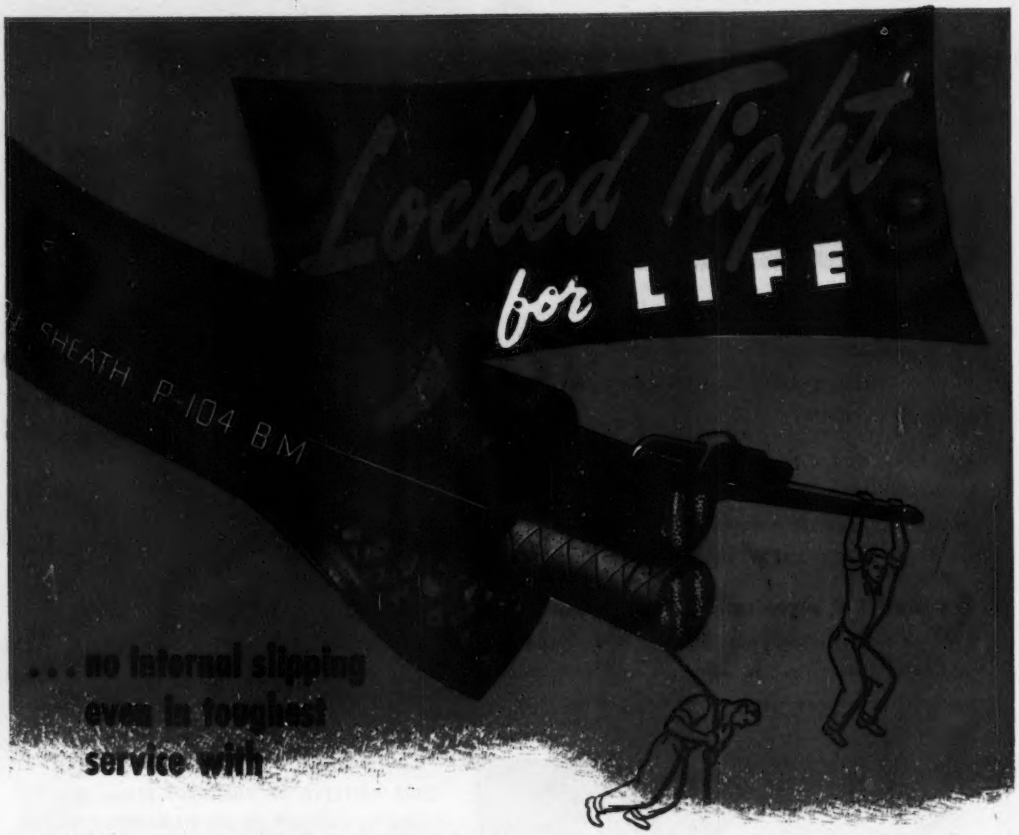
POWERFUL DRILLS *are made to meet the requirements of deep hole drilling.*

● CONSULT US ON THE PROBLEM OF INCREASING YOUR MINERAL RESERVES

E. J. LONGYEAR COMPANY

CANADIAN LONGYEAR LIMITED, NORTH BAY, ONTARIO, CANADA

DIAMOND CORE DRILLS • CONTRACT CORE DRILLING
SHAFT SINKING • GEOLOGICAL INVESTIGATIONS



HAZACORD

TWIN PARALLEL TRAILING CABLE

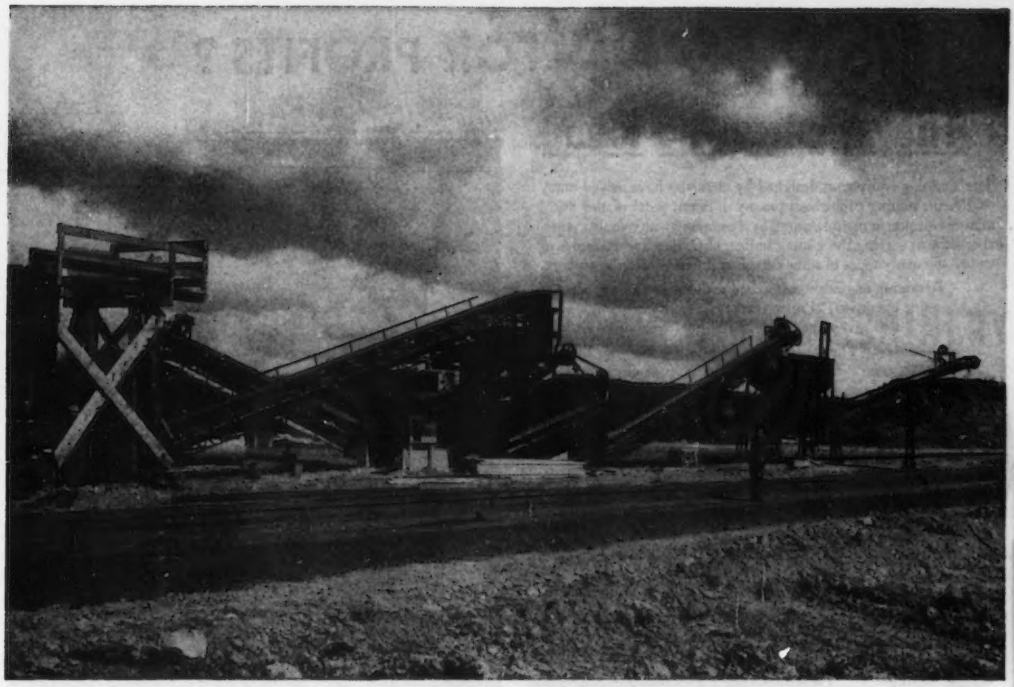
Experience has shown, as you have probably found yourself, that when a twin parallel trailing cable works loose internally — its days are numbered. Hazard's new design prevents this costly trouble — as has been proved out in actual mining service. It's designed especially for shuttle car operation where cable is subject to high-speed reeling.

The tough, long-wearing, flame-resistant Hazaprene ZBF Sheath completely encases *each* insulated conductor — *doubles* the holding surface between insulated conductors and sheath, which are firmly bonded and interlocked to form one integral mass. And this extra wall of Hazaprene between conductors also prevents shorting, adds to the cable's flame-resistance. It's an excellent life-saving cushion, too, when cable is run over by equipment.

You'll find this Hazacord cable engineered throughout to give you longer, safer, more economical service than you ever had before from twin parallel trailing cable. The braid over the insulated conductors is made with a tough, reinforcing cord. Grounding conductor is highly flexible, compact and easy to splice. Over-all cable flexibility is ample for your highest-speed-reeling requirements. And the exceptionally abrasion resistant Hazaprene ZBF Sheath provides maximum flame-resistant qualities — more than meets the newest flame-test requirements of U.S. Bureau of Mines and Pennsylvania Department of Mines — "P-104 BM" is molded into sheath at frequent intervals.

For more information or a sample, see your Hazard representative or write Hazard Insulated Wire Works, Division of The Okonite Company, Wilkes-Barre, Pa.

HAZARD insulated wires and cables for every mining use



Concentrate...100 tons an hour!

One of the most efficient ore washing plants on the Mesabi Range was recently set up by the Hedman Mining Company. It is located near Buhl, Minnesota. Production has averaged 90 to 100 tons of concentrate an hour . . . recovery 65% to 70% of input. Here's how it operates:

Ore is trucked to washing plant and dumped into a receiving hopper located over a Pioneer 30″ Reciprocating Plate Rock Feeder. A Pioneer 30″ Conveyor receives the material from feeder discharging it on the Pioneer Triple Deck Screen (5′x12′).

Screening. The 4″ oversize from the top deck of the screen is carried to a Pioneer 10 yard Rock Bin by another Pioneer 24″ Conveyor.

Screened material from the middle and bottom decks converges and is carried to a Pioneer Surge Bin by Pioneer Belt Conveyors.

Fines passing the bottom deck pass through a Twin Screw Classifier. These also go to the Surge Bin. A Pioneer 18″ Conveyor loads ore cars direct from Surge Bin.

Power. The main plant and feeder conveyor are driven by V-belt direct from a diesel unit. This same diesel also drives a 25KW generator which supplies power for electric motors on three other conveyors. A second diesel unit powers a pump which furnishes water for the classifier.

In addition to Conveyors, Screens, Bins and Feeders, Pioneer has designed other tough, rugged equipment for the mines. Huge Pioneer Jaw and Roll Crushers, the Pioneer-Oro Manganese Steel Apron Feeder, Mesabi Heavy-Duty Conveyors are building unsurpassed records for high production and minimum maintenance.

Mail the coupon today for catalog.

BUY BOTH!
Higher Output, Lower Upkeep!

Pioneer
Continuflo **EQUIPMENT**

MAIL COUPON TODAY!

PIONEER ENGINEERING WORKS
1515 Central Avenue • Minneapolis 13, Minnesota

● Please send information on the products checked:

☐ WASHING PLANTS ☐ HEAVY-DUTY VIBRATING SCREENS
☐ PIONEER-ORO APRON FEEDERS ☐ JAW CRUSHERS
☐ CONVEYORS ☐ ROLL CRUSHERS

Name_____

Company_____

Address_____

City_____ State_____

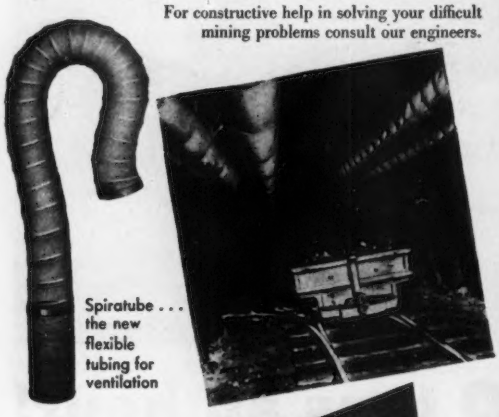
DIGGING FOR PROFITS?

They'll carry the load!

Here's mining equipment designed by men who have solved many difficult mining problems in many different parts of the world . . . mining equipment manufactured by a company with over 50 years' experience in serving the mining industry! Only a few examples of the many types of mine cars manufactured are shown here.

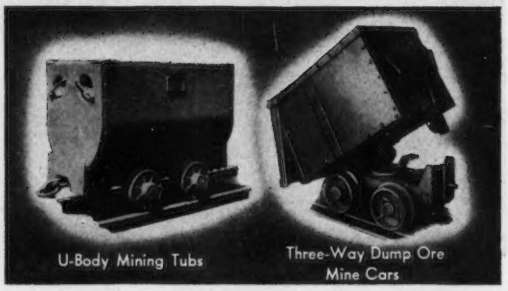
To mining engineers concerned with the increasing costs of mine operation, "Pressed Steel Car Company" equipment will give dependable, efficient, trouble free service.

For constructive help in solving your difficult mining problems consult our engineers.



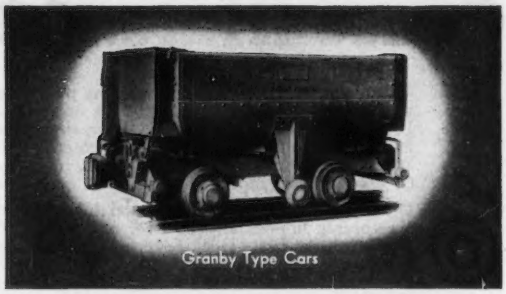
Spiratube . . . the new flexible tubing for ventilation

Mining Locomotives



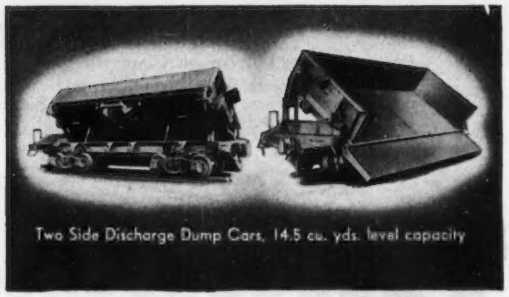
U-Body Mining Tubs

Three-Way Dump Ore Mine Cars



Granby Type Cars

Track work and car parts



Two Side Discharge Dump Cars, 14.5 cu. yds. level capacity

Other Products...

WEST VIRGINIA STEEL and MANUFACTURING CO.
Steel rails, steel crossties, track accessories, switches, crossings, frogs, etc.

THE FATE-ROOT-HEATH COMPANY
Brick manufacturing machinery.

PLYMOUTH LOCOMOTIVE WORKS
Internal combustion motor locomotives from 3 to 70 tons (alcohol, gasoline, Diesel and Diesel-electric).

WOOLERY MACHINE COMPANY
Weed burners, gang cars, rail motor cars.

FLEXIBLE TUBING CORPORATION
Flexible Tubing.

PSC

Steelcar

PRESSED STEEL CAR COMPANY, Inc.

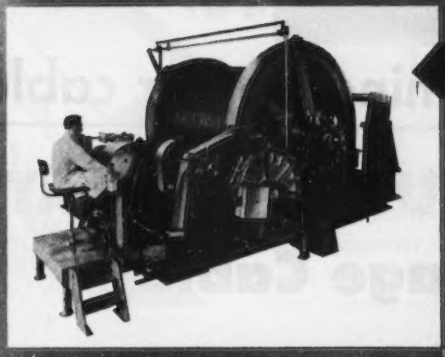
Export Division, 25 Broad Street, New York 4, N. Y.

LIDGERWOOD

DESIGNERS AND BUILDERS

OF QUALITY HOISTING MACHINERY

Since 1873

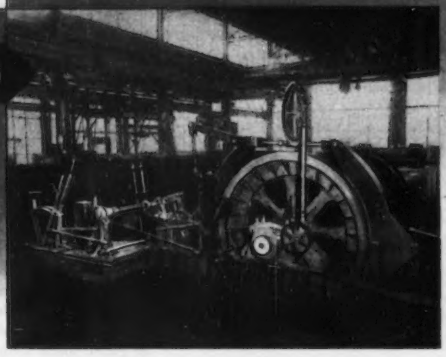


SLOPE HOISTS

Illustrated is a two speed Slope Hoist for load of 35,000 Lbs. on a 5300 foot incline with a maximum grade of 39° 10'. Rope 1¾" diameter. Drum 92" diameter x 102" face, welded steel. Herringbone Gears. Low speed 200 F.P.M. High speed 400 F.P.M.

SHAFT HOISTS

This Shaft Hoist furnished to handle a "pay load" of 25,000 Lbs. in a 1100 ft. deep shaft at 750 F.P.M. Maximum cross load on drum shaft 68,800 Lbs. Drum, welded steel, 96" diameter x 124" face. Rope 2⅛" diameter. Herringbone Gears. 108" Post Brake.



We also build Drill and Exploratory Hoists

Superior—Lidgerwood—Mundy Corporation

MAIN OFFICE AND WORKS — SUPERIOR, WISCONSIN

NEW YORK OFFICE—7 Day St., New York 7, N. Y. EXPORT OFFICE—50 Church St., New York 7, N. Y.

Cable Address — BROSITES, NEW YORK

looking
for a

tough mine power cable?

it's **ANACONDA BUTYL-INSULATED**

High Voltage Cable

No metal armor or lead sheath, yet . . .
There's even greater mechanical and electrical protection in the combination of *neoprene jacket* and *butyl insulation.*
Together they provide:
Unequalled protection from impact, crushing, twisting and abrasion.
Higher dielectric strength.
Greater resistance to moisture, acids, oils, ozone, heat and flame.
Less weight, more flexibility; easier to handle, install, splice and maintain. Lower first and final costs!

81349

ANACONDA Butyl-Insulated High Voltage Cable is the modern cable for any mine—particularly mechanized mines. Anaconda also specializes in the manufacture of shuttle car cable and cable for the new continuous mining machines. Let our mine service specialists show you, or get in touch with your near-by Anaconda Distributor. Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

the right cable for the job

ANACONDA®
WIRE AND CABLE

FUMEALL*

TRADE-MARK

the superior filter fabric for fume, dust and liquid filtration

FUMEALL filter fabric is setting new standards for fume, dust and liquid filtration. It has proved superior to all other filter media wherever tested under actual operating conditions. Compare the features of **FUMEALL** with those of any other filter medium and you'll see why—

***What is* FUMEALL?**

FUMEALL is a combination of virgin wool and synthetic staple fibers. This combination gives the undisputedly superior filtering qualities of virgin wool plus the strength, heat, acid, alkali, and moisture-resistance of synthetic fibers.

How long does* FUMEALL *last?

In actual operations, **FUMEALL** is lasting 4 times as long (and in many instances much longer) as conventional all-wool filter fabrics.

How much does* FUMEALL *cost?

The initial cost of **FUMEALL** is little more than any good all-wool filter fabric. Yet when measured in terms of longer life and superior performance, **FUMEALL** costs far less.

***How resistant is* FUMEALL?**

FUMEALL operates successfully in temperature ranges far beyond those permitted by conventional all-wool filter fabrics (225° to 300°), has greater fire-resistance than most synthetics. In intermittent operations, moisture absorption of **FUMEALL** is 50% or less than that of conventional all-wool filter fabrics, and shows greater resistance to acids and alkalis present in various filtered fumes and liquids.

***What is the porosity of* FUMEALL?**

You can get exactly the porosity you want with **FUMEALL**, the right weave for your specific requirements. At present, **FUMEALL** is available in 4 different weights from most porous 14-oz. to least porous 24-oz. Finer or coarser weaves are available on special order, and **FUMEALL** can be napped or unnapped to conform to various operating conditions.

What about* FUMEALL *sizes?

FUMEALL is "tailored to your needs". Portland Woolen Mills will weave yardage or fabricate bags to any size and specification.

FumeAll is proving highly satisfactory for vacuum filtration in drum, disc and leaf type filters as well as bag type filters. Write or send coupon for samples and details.

INDUSTRIAL FABRICS DIVISION

Portland Woolen Mills, Inc.

P.O. Box 2620 • Portland 3, Oregon

*Patent Pending

Industrial Fabrics Division
PORTLAND WOOLEN MILLS, Inc.
P.O. Box 2620, Portland 3, Oregon

Please send me additional details and samples of **FumeAll** suitable for
☐ fume collection ☐ dust collection ☐ liquid filtration

Name_____ Title_____

Firm_____

Address_____

City_____ Zone____ State_____

DUSTS MISTS FUMES

from:

CRUSHERS

DRYERS AND ROASTERS OF ALL TYPES

FURNACES

KILNS

FLUOSOLID REACTERS

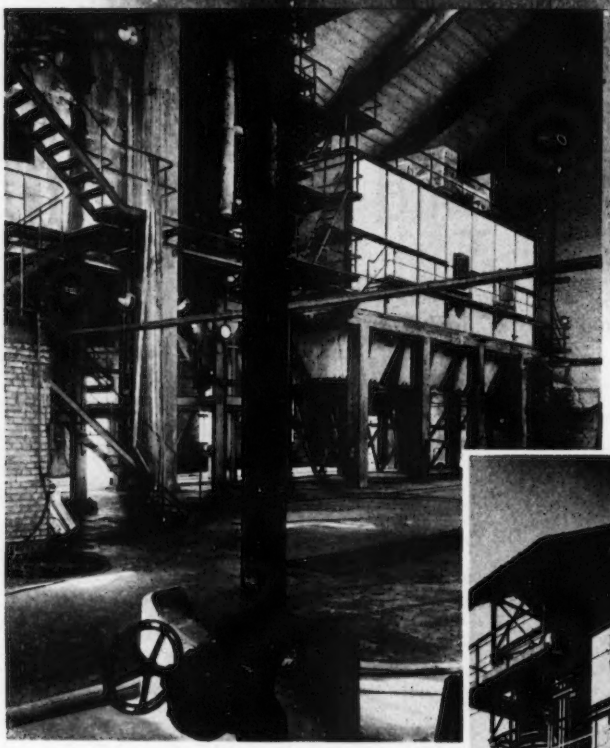
SINTERING MACHINES

SCREENS

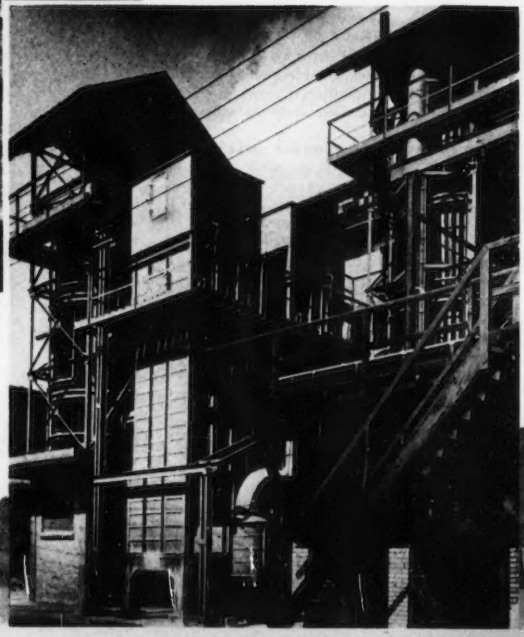
MIXERS

CONVEYORS

BOILERS
(solid fuel firing)



Dry dust collection from flue gas in Nichols Freeman furnace with a Buell 'SF' Precipitator



Buell 'SF' Mist Precipitator from gas in a roaster furnace.

PHOTOS BY C. E. ROSENBERG, A. R. P. S.

There's more dollars in Recovery with Buell 'SF' Precipitators

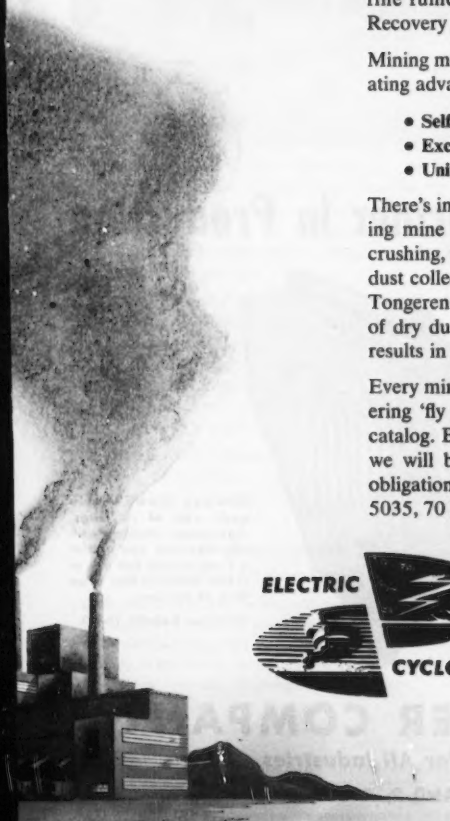
Now, more than ever before, the economic justification of recovery of 'fly away' dollars becomes increasingly important. From non-metallics to precious metals... from coarse dust to fine fumes—there's saving to be made with a Buell Dust Recovery System.

Mining men, on the alert, are finding new and important operating advantages in the Buell 'SF' Electric Precipitator:

- **Self-tensioned Spiralectrodes**
- **Exclusive Stediflow dust fall**
- **Unitized high-voltage Power Pack**

There's importance, too, in considering the advantage of freeing mine and smelter operations from the nuisance dust in crushing, milling, or dry handling operation. Here, mechanical dust collection may be the economical choice. The Buell van Tongeren Cyclone comes in for consideration in the recovery of dry dust of average particle-size. Its exclusive 'Shave-Off' results in efficiencies that warrant a thorough investigation.

Every mining man confronted with the responsibility of recovering 'fly away' dollars should have a copy of Buell's latest catalog. Better still, if you will outline your specific problem, we will be glad to apply our engineering experience... no obligation, of course. Write Buell Engineering Company, Suite 5035, 70 Pine Street, New York 5, N.Y.



ELECTRIC CYCLONIC®

buell®

Dust Recovery

Norblo

Yellow Pine Antimony Smelter, Stibnite, Idaho, producers of Elk Brand Antimony Oxide.

Smelting Industry's Silent Partner In Production

Ninety per cent of the antimony mined in the United States is with Norblo Automatic Bag Type Dust-and-Fume Collectors, at the smelters shown above. Here seven separate Norblo bag houses are used in the roasting, smelting, refining or conversion of antimony, gold and tungsten.

In other smelting fields Norblo is equally outstanding. For example, three out of the four largest modern lead and zinc slag fuming plants in North America have Norblo automatic bag houses.

The heavy duty continuous service Norblo bag type fume and dust collection equipment has made and is still making a most important contribution to national welfare.

Cutaway shows Norblo basic unit of 78 bags. Automatic shaking and bag cleaning, one unit at a time, insures full use of cloth area better than 99% of the time.

Write for Bulletin 164-2

THE NORTHERN BLOWER COMPANY

Engineered Dust Collection Systems for All Industries

6410 BARBERTON AVE. • CLEVELAND 2, OHIO

WHAT WOULD **YOU** SPECIFY . . .

Fluid	Concentration	Temp.	Type of Valve	Valve Material
1 Sulphuric Acid	20%	120 F.		
2 Sulphuric Acid	100%	180 F.		
3 Hydrochloric Acid	32%	80 F.		
4 Hydrofluoric Acid	50%	125 F.		
5 Beer		200 F.		
6 Oxygen		Ambient		

We supplied Grinnell-Saunders Diaphragm Valves with . . .

Body Material	Diaphragm Material
1 Rubber lined	Natural rubber
2 Cast iron	KEL-F
3 Glass lined	Butyl
4 Magnesium	KEL-F
5 Polished bronze	White diaphragm
6 Cast iron*	Neoprene

*For oxygen service a low flash point lubricant is supplied. All valves for oxygen service are subjected to 300 lb. air underwater test.

In several of these cases other body materials or diaphragms would serve as well. But the really important fact is the unmatched versatility of Grinnell-Saunders Diaphragm Valves in handling corrosive fluids, gases, compressed air, food and suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are problems.

Grinnell-Saunders Valve bodies are stocked in cast iron, malleable iron, stainless steel, bronze, and aluminum, with other materials available on special order. Valve bodies can be lined with lead, glass, natural rubber or neoprene. Diaphragms are available of natural rubber and a number of synthetics to suit particular service conditions.

The Grinnell-Saunders Valve Division will be pleased to submit recommendations upon receipt of complete information covering service conditions.

Features of the Grinnell-Saunders Diaphragm Valve

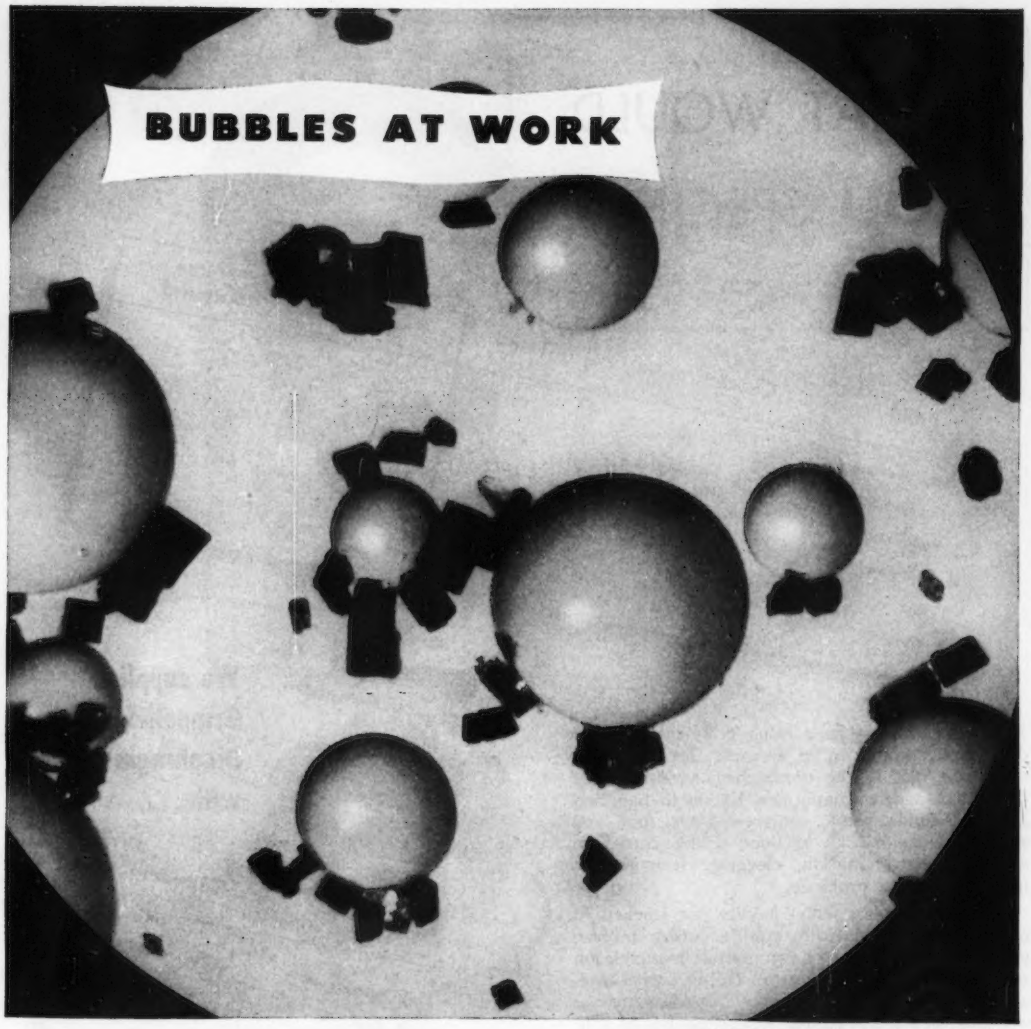
- diaphragm absolutely isolates working parts from fluid
- diaphragm lifts high for streamlined flow in either direction
- diaphragm presses tight for positive closure
- body, lining and diaphragm materials to suit service
- simple maintenance—diaphragm easily replaced

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company Inc., Providence, Rhode Island • Sales Offices and Warehouses in Principal Cities

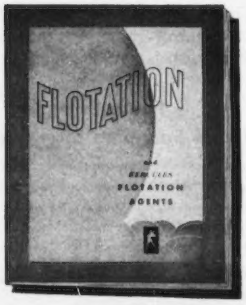
pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco humidification and cooling systems



Photomicrograph greatly enlarged, by H. Rush Spedden

To help step-up flotation recoveries at low cost, Hercules has developed a number of frothers and collectors. Yarmor® F Pine Oil has been a standard of quality among pine oil frothers since the early 1920's. RADA (Hercules' Rosin Amine D Acetate) is a siliceous mineral collector that has good solubility and is easy to handle. It is used in the commercial flotation of several nonmetallic ores. These and other Hercules products are described in a 16-page technical booklet, "Flotation and Hercules Flotation Agents." This booklet also contains many formulas useful in the operation and control of modern ore-dressing mills. *Send for your copy.*

HERCULES POWDER COMPANY 933 King St., Wilmington, Delaware



HERCULES Flotation Agents

NM51-1

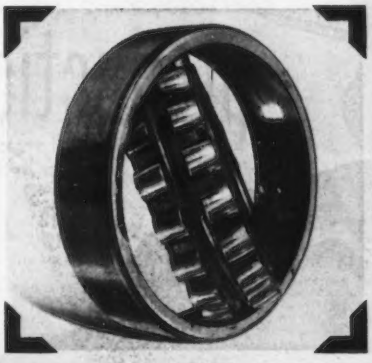
STANDARD ENGINEER'S REPORT

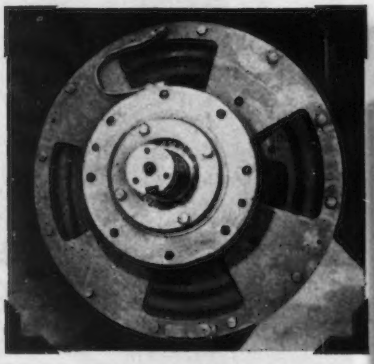
DATA

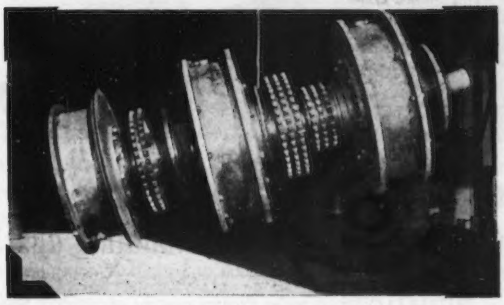
LUBRICANT	Calol SA Grease
UNIT	Heavy-duty roller bearing
LUBRICATOR	Grease gun
CONDITIONS	Loads to 15,000 lbs.-speeds to 800 RPM-Dust, shock
PERIOD	2½ years
FIRM	Ideco, Torrance, Calif.

Bearings good after 2½ years heavy-duty outdoor service!

THIS BEARING and its mate supported a 2000-pound transmission shaft assembly in an oil-well drill-rig hoist for 2½ years while the unit drilled more than 100,000 feet of hole. Lubricated with CALOL SA Grease, bearings were in good condition (see picture) when checked at the end of that time and were put back in service. As the unit lifted and lowered heavy drill tools, bearings were subjected to terrific shock loads. Dust and grit were always present in the air in the outdoor operation.



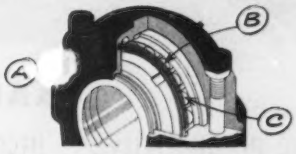




THE TRANSMISSION INPUT SHAFT ASSEMBLY was removed from the hoist to repair a flange ring, allowing checking of the bearings. All bearings are hand packed with CALOL SA Grease by the manufacturer of the hoist, Ideco, Torrance, California, before delivery of a unit. Fittings and tubes provide for lubrication with a grease gun on the job.

REMARKS: High-melting-point CALOL SA Grease covers a wide range of applications. You will find it especially valuable for all of your anti-friction and plain bearings that operate in surrounding air temperatures above 200°F.

How to reduce wear in all types grease-lubricated machine bearings



Specialized CALOL SA Grease will provide constant lubrication in high ambient and bearing temperatures—proved in mill ambient temperatures of 250°F. and Navy Ball Bearing Machine tests of 10,000 rpm and extreme temperatures.

A. Made from sodium-aluminum base...very high melting point minimizes seepage.

B. Feeds evenly to all bearing surfaces.

C. Remains soft in cold temperatures.

FOR MORE INFORMATION about this or other petroleum products of any kind, or the name of your nearest distributor handling them, write or call any of the companies listed below.

TRADEMARK "CALOL" REG. U.S. PAT. OFF

STANDARD OIL COMPANY OF CALIFORNIA
225 Bush Street • San Francisco 20, California

THE CALIFORNIA COMPANY
P. O. Box 780 • Denver 1, Colorado

STANDARD OIL COMPANY OF TEXAS
P. O. Box 862 • El Paso, Texas

plan on dust control for "forced draft" production

AAF ROTO-CLONES

improve productivity . . . increase material salvage . . . by eliminating dust!

NOW that every pound of metal is important . . . remember *dust control!* Make it a part of plans to help production — new ideas to increase capacity. A look at ROTO-CLONE'S record for high efficiency dust elimination indicates the importance of cleaning up dust sources in the mining cycle. Here are some of the operations where ROTO-CLONES contribute to high capacity output.

- Dust-free crushers, screens, conveyors increase production with improved working conditions . . . maintain mechanical efficiency.
- Salvage of material from milling, sampling, sintering operations provides greater control of product loss.
- Cleaning high temperature gases from Dryers, Roasters eliminates toxic and nuisance elements.

*ROTO-CLONE is the trade-mark (Reg. U.S. Pat. Off.) of the American Air Filter Company, Inc., for various dust collectors of the dynamic precipitator and hydro-static precipitator types.

WRITE FOR THIS FREE BULLETIN!

AAF Engineering Bulletin No. 270A contains complete information on the design and application of both wet- and dry-type Roto-Clone dust collectors. For the answers to your difficult dust collection problems—write for a copy today.

AAF

three case histories of **ROTO-CLONE** efficiency:

CASE HISTORY NO. 1

94%+ removal on a dust count basis by Type W ROTO-CLONE serving secondary crusher in rock house of large copper mine.

CASE HISTORY NO. 2

Type N ROTO-CLONE, exhausting sintered lead ore at crushers, removes 98.2% of dust by weight.

CASE HISTORY NO. 3

99.7% dust removal by weight by Type W ROTO-CLONE on copper ore milling operation.

AAF ROTO-CLONE "engineered dust control" has solved practically every dust problem in the mining cycle. Dust-free operations improved human and mechanical efficiency, salvage of valuable products, and lowered maintenance costs. When planning for increased capacity, you should have the correct answers to these important questions.

QUESTION NO. 1—*What efficiency can be expected from a wet-type ROTO-CLONE on extremely fine dust?*

ANSWER—Hundreds of Type W and Type N ROTO-CLONES are functioning daily at better than 98% efficiency on small micron particles such as found in ore crushing and screening, material drying, roasting and sintering operations. It is not uncommon to obtain efficiencies of 99.5% on such applications. Constant performance and uniform air delivery is not effected by temperature or moisture.

QUESTION NO. 2—*Does operation of wet-type ROTO-CLONE require a large volume of water?*

ANSWER—The ROTO-CLONE system of bringing dust to the water makes effective use of every gallon supplied.

Where water disposal is a problem the Type N is available. This unit recirculates water without aid of pumps or nozzles. Water consumption is limited to small amount required to provide for evaporation.

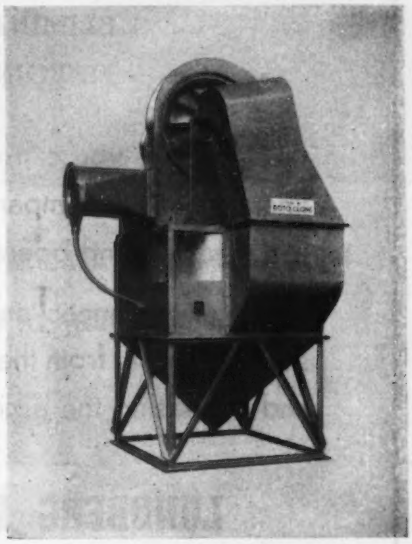
QUESTION NO. 3—*Is ROTO-CLONE dust collection expensive?*

ANSWER—The cost of a ROTO-CLONE system is no more expensive than other dust collectors of comparable efficiency. Actually, due to small space requirements and factory method of assembly, the installed cost of a ROTO-CLONE is usually less.

For correct answers to other questions on dust control planning . . . write to American Air Filter.

TYPE N ROTO-CLONE ARR. D — CUTAWAY

A Hydro-Static Precipitator of high efficiency. Removes dust by dual washing and scrubbing action. No moving parts. Combines in one unit the three functions of exhausting, separating and intermittent or continuous dust sluicing . . in the form of sludge. Available in capacities from 750 CFM to 45,000 CFM.



TYPE W ROTO-CLONE ARR. D

A Dynamic Precipitator with integral water sprays maintaining a moving water film on all collector surfaces. This results in maximum efficiency on even very fine dust particles. Is able to handle steam and water vapor without plugging and to collect heavy concentrations of abrasive dust without excessive wear. Available in capacities from 1000 CFM to 48,000 CFM.

American Air Filter
COMPANY, INC.
193 Central Ave., Louisville 8, Ky. • In Canada: Darling Bros., Ltd., Montreal, P. Q.

ELECTRIC, MAGNETIC, and RADIOACTIVITY SURVEYS from the AIR For OIL, GAS, and HARD MINERALS

- SAVE TIME AND MONEY
- FOCUS ON RIGHT AREA
- ELIMINATE UNLIKELY AREAS
- PINPOINT POSSIBLE AREAS

In ONE DAY you can easily survey BY AIR, from 150 to 450 linear miles—as compared to slow and laborious ½ to 2 miles a day of ground operations.

Electrical, Magnetic and Radioactivity surveys may be done simultaneously from the same craft, thus greatly reducing costs and increasing the accuracy of interpretation of survey data.

LUNDBERG EXPLORATIONS LIMITED
HANS LUNDBERG LIMITED

VICTORY BUILDING TORONTO 1 CANADA

ANOTHER
COPPUS
"BLUE RIBBON" PRODUCT
This is the Coppus VENTAIR. A centrifugal blower, it is designed for long pipe lines, high pressures.
This is the Coppus VANO. The propeller type, best for shorter pipe lines, medium pressures.

These are the cost-reducing Blowers that give up to 100% more air

Only Coppus makes both types — and both are made especially for *mine* ventilation. One or the other, operating under the conditions for which it is designed, delivers from 30% to 100% more air for a given power consumption than an ordinary all-purpose fan.

They can be used as blowers or exhausters and are driven either by compressed air or electric motor, with capacities up to 90,000 CFM. Like all Coppus products, these blowers wear the "Blue Ribbon" that stands for high achievement in engineering, workmanship and performance.

Representatives listed in MINING CATALOGS. Other Coppus "Blue Ribbon" products: steam turbines, gas burners, heat killers, air filters, blowers and exhausters for special purposes. See also THOMAS' REGISTER . . . Coppus Engineering Corp., Worcester 2, Mass.

COPPUS ENGINEERING CORPORATION
287 Park Avenue, Worcester 2, Mass.

Please send.....Bulletin 130

Name .....

Company .....

Address .....

ROTARY SINTERING KILNS

Iron ore, manganese ore, phosphates of all sizes, flotation concentrates and flue dust alone or mixed, can be sintered regardless of moisture and carbon content.

Sintering temperature easily regulated and maintained as desired, producing sinter of proper porosity and hardness, thus saving blast furnace fuel.

Materials sintered without fines, eliminating screening and rejects.

Any available gas, oil or pulverized solid fuel may be used.

Low power consumption—7 to 8 kwh per ton of sinter.

F. L. SMIDTH & CO.

11 WEST 42ND STREET NEW YORK, N. Y.

There's a better way to separate your minerals . . .

Use Armour's Flotation Reagents !

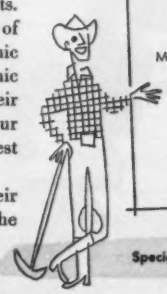
Froth flotation, the modern milling method, means longer life, greater productivity and more economical separations for your mine. Yields of a given ore are raised by: (1) making separations once considered economically impossible, (2) making higher grade concentrates possible, (3) recovering more than one concentrate and (4) concentrating minerals lost in tailings.

Vital to profitable flotation is the uniform high quality of the reagents. The pioneering Armour Chemical Division produces a wide range of quality chemical reagents—both anionic and cationic. In the anionic category are Armour's fractionally distilled fatty acids. The cationic group includes the high molecular weight aliphatic amines and their water soluble amine salts, as well as quaternary ammonium salts. Armour manufactures these fatty acids and fatty acid derivatives under the strictest chemical control.

If you have a separation problem involving the listed ores and their associated minerals, Armour's technical service staff may provide the answer. Write today for more information.

PROVEN SEPARATIONS

Amblygonite • Barite • Beryl
Cement Rock • Chromite
Feldspar • Fluorspar
Hematite • Ilmenite
Kaolinite • Magnetite
Manganese • Manganite • Mica
Phosphate • Potash • Salt
Silica • Spodumene
Syenite • Talc • Tin
Vermiculite



Specialists in Flotation Chemicals

ARMOUR *Chemical Division*

Armour and Company • 1355 W. 31st Street • Chicago 9, Illinois

Republic Tips

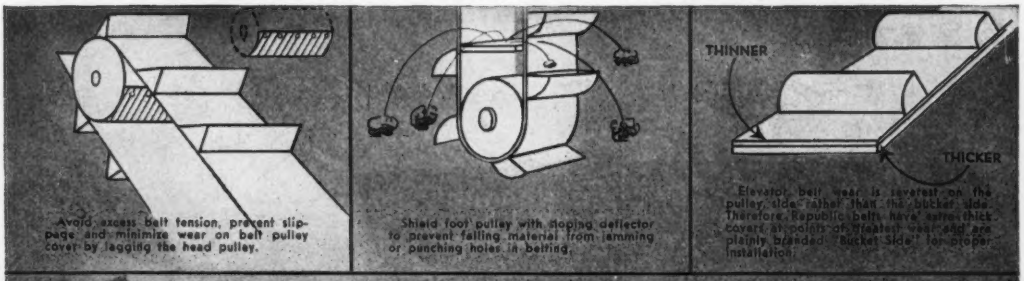
TO ELEVATOR BELT USERS

● With Republic Elevator Belting on the job, you're set to handle bigger pay loads with less trouble.

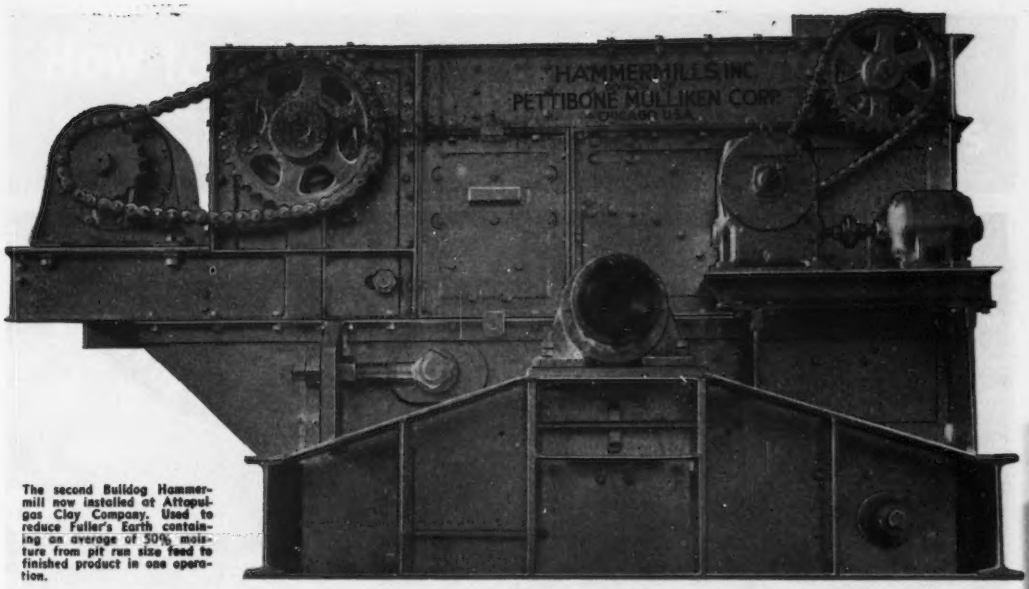
Don't lose this advantage by improper methods of application and maintenance!

Your local Republic Rubber Distributor can show you many ways to improve efficiency and increase service life of elevator belts. As an experienced specialist, he is fully prepared to help you select exactly the right Industrial Rubber Product for your requirement. Contact him today.

Remember, Republic Rubber has been *the* specialist in the field of Industrial Rubber Products for more than 50 years. Use Republic products and you use the best. Use Republic products *correctly* and you save the most!


Avoid excess belt tension, prevent slippage and minimize wear on belt pulley cover by lagging the head pulley.
Shield foot pulley with sloping deflector to prevent falling material from jamming or punching holes in belting.
THINNER
THICKER
Elevator belt wear is severest on the pulley side rather than the bucket side. Therefore, Republic belts have extra thick covers at points of greatest wear and are plainly branded "Bucket Side" for proper installation.

stop costly breakdowns
with REPUBLIC ELEVATOR BELTING!
Republic Elevator Belting is built to stand up under the most gruelling working conditions.
Made in full-edge construction with multiple plies of heavy, prestretched, rubber-insulated fabric, Republic Elevator Belting is specially designed to resist bolt pull at the buckets.
Tough abrasion-resistant black rubber covers give belt carcasses maximum protection . . . stand up longer under more severe service requirements.
Republic Elevator Belting is supplied in all standard widths and plies. All fabrics are permanently treated against mildew.
See your local Republic Distributor or write direct for full facts.
INDUSTRIAL RUBBER PRODUCTS BY
REPUBLIC RUBBER DIVISION
Lee Rubber & Tire Corporation
YOUNGSTOWN, OHIO



The second Bulldog Hammermill now installed at Attapulgas Clay Company. Used to reduce Fuller's Earth containing an average of 50% moisture from pit run size feed to finished product in one operation.

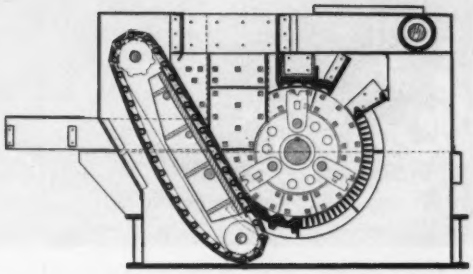
BULLDOG HAMMERMILL

with moving Breaker Plate

For wet, sticky material reduction . . . for those tough, heavy-duty crushing jobs.

Illustrated above is the last word in Moving Breaker Plate Hammermill design. It is built by an engineering organization whose experience far surpasses any organization that might furnish Moving Breaker Plate crushing equipment.

Design Improvements have increased reduction efficiencies and lowered H.P. requirements. You can see this equipment in operation at any time. Also Hammermills will gladly survey your reduction requirements and recommend the proper equipment without cost or obligation. Just write or call.



Bulldog Hammermills are built in capacities up to 1000 tons per hour for every purpose: for primary, secondary, fine reduction of materials such as limestone, shale, Fuller's Earth, phosphate muck, phosphate mud balls, iron ore, oyster or clam shells, any reducible material.

HAMMERMILLS, INC. • 4777 W. Division St.
Chicago 51, Ill. • Phone Spaulding 2-9300

division of

PETTIBONE MULLIKEN CORP. • 4700 W. Division St.
Chicago 51, Ill. • Phone Spaulding 2-9300

Want to Move a Mountain in a *Hurry?*

● The equivalent of a mountain must be moved in a few years to produce a profitable operation in many mines, quarries, coal stripping operations and big construction jobs.

If your requirements call for several years of high-yardage production in the toughest kind of digging, you'll want to know about the MARION 151-M.

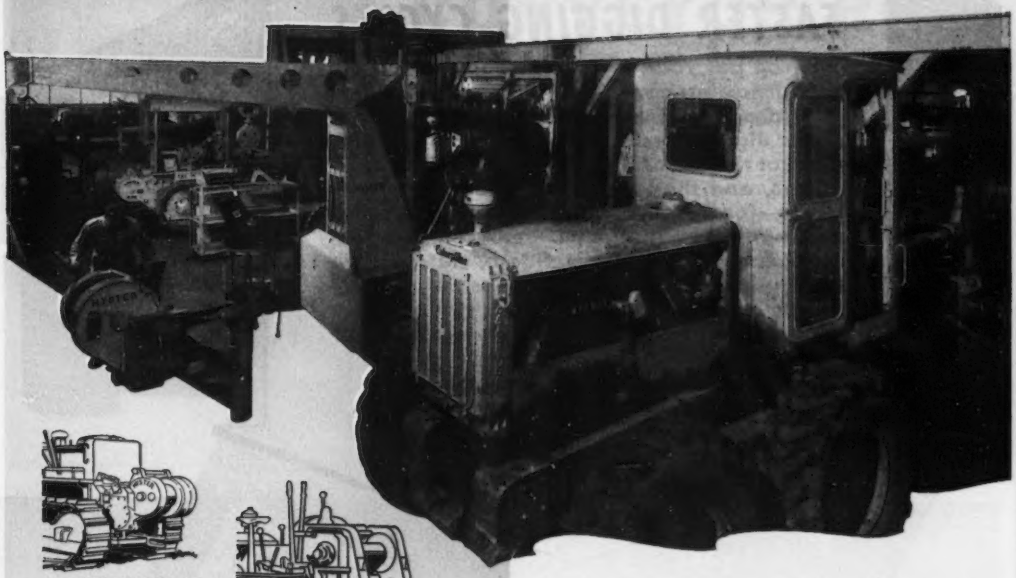
It was developed expressly for companies that need to get big jobs done quickly and dependably. Examine the 151-M in detail—see its rugged, heavy-duty electrical system—its sheer strength and size—its record of dependability in the heaviest kind of work. Your nearest MARION sales office can give you the details—or contact the sales headquarters at Marion, Ohio.

MARION POWER SHOVEL CO.
MARION, OHIO, U. S. A.

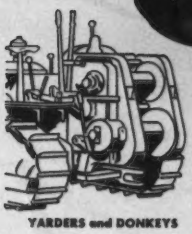
OFFICES AND WAREHOUSES IN ALL PRINCIPAL CITIES

from 3/4 cu. yd. to 45 cu. yds.

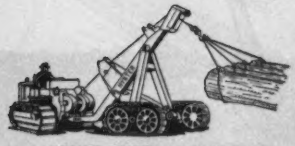
How to Make Your CATERPILLAR-HYSTER® Equipment Last More Years



TOWING WINCHES

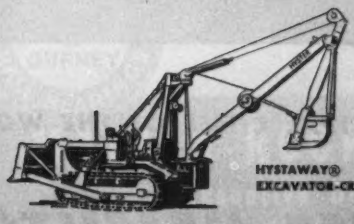


YARDERS and DONKEYS



LOGGING ARCHES and SULKIES®

GRID ROLLERS



HYSTAWAY® EXCAVATOR-CRANES

Put yourself in the hands of your Caterpillar Tractor Company dealer. He can keep your tractor and tractor tools running better at lower cost. He has factory trained mechanics who *know* Caterpillar and Hyster equipment. He backs up skilled mechanical knowledge with an efficient parts department.

Service is his business. And the times being what they are, we suggest that you rely upon your dealer to keep your Caterpillar tractor and Hyster tractor tools working at full capacity longer.

HYSTER COMPANY

2965 N. E. CLACKAMAS STREET, PORTLAND 8, OREGON
1865 NORTH ADAMS STREET, PEORIA 1, ILLINOIS

HIGHER DUMP, GREATER REACH, FASTER DIGGING CYCLES

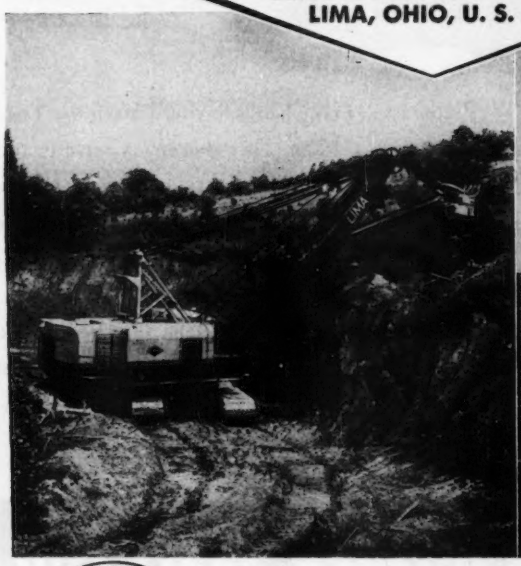
that's the LIMA 2400

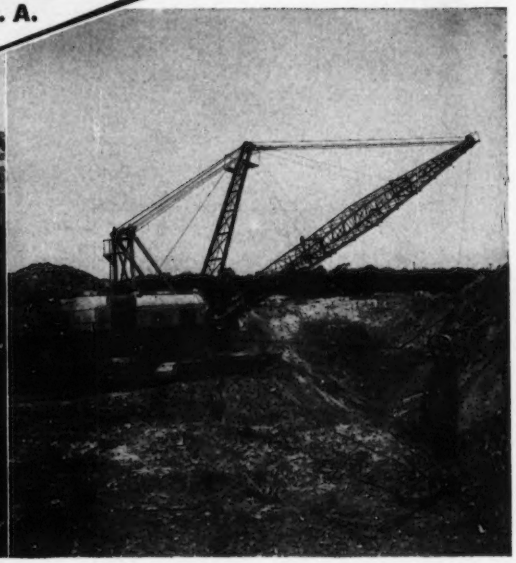
You can put your stripping schedule on a big production basis with a LIMA Type 2400 shovel or dragline. Their greater working range, faster digging cycle and easier control places them at the top of the list of big yardage producers, and they have plenty of bonus features—for instance, all major operations are accomplished through air-actuated clutches, drums are mounted in tandem, clutches are full mechanical, free from constant adjustments and anti-friction bearings protect every important bearing point against power robbing friction.

ANTI-FRICTION BEARINGS, AIR CONTROL, LARGE DIAMETER DRUMS, ECONOMICAL DIESEL POWER, ROCK & CONICAL ROLLERS, CONVERTIBLE IN THE FIELD

FOR DETAILS OF CONSTRUCTION AND SPECIFICATIONS WRITE FOR A COPY OF BULLETIN NO. 240.

BALDWIN-LIMA-HAMILTON CORPORATION
LIMA-HAMILTON DIVISION
LIMA, OHIO, U. S. A.



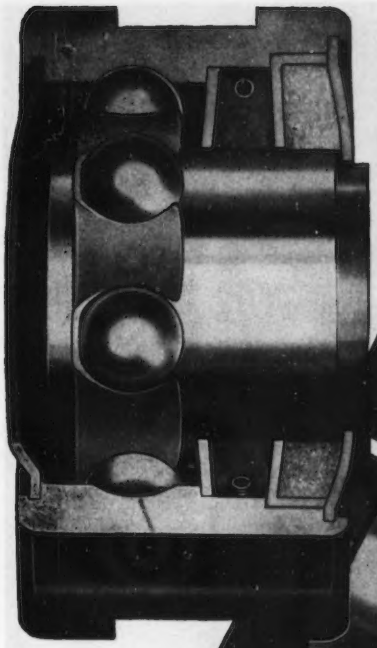


BALDWIN BLH LIMA-HAMILTON

SALES AGENTS IN PRINCIPAL CITIES OF THE WORLD

BALDWIN-LIMA-HAMILTON

T2102



M-R-C
CONVEYOR ROLL BEARINGS

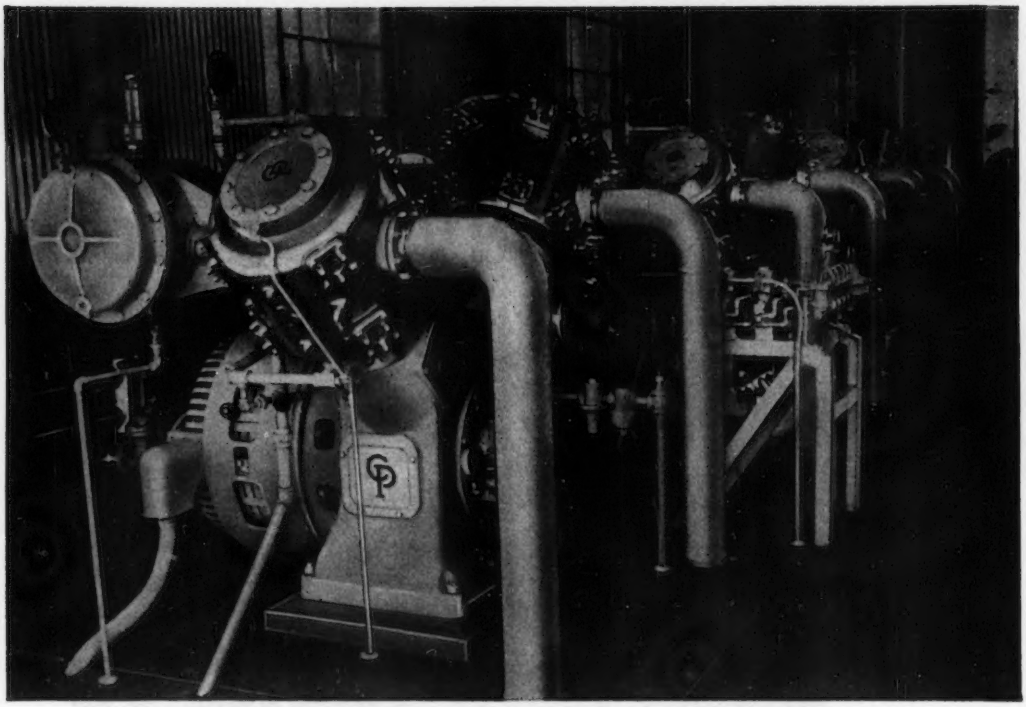
This bulletin contains complete information on
M-R-C CONVEYOR ROLL BEARINGS
File it with your Ball Bearing Data
Four Important Features
Freedom from need of lubricating
Improved bearing seal
All exterior surfaces rust-resistant
Easily replaceable
Resulting in:
Reduced machining operations
Cheaper mounting costs
Reduced belting cost
Improved belt alignment
In the M-R-C Conveyor Roll Bearing are incorporated features of design that effect radical improvements in, both conveyor maintenance—with no increase in cost of manufacture—with important savings in maintenance to operators.
M-R-C Conveyor Roll Bearings are manufactured by a concern which has been making anti-friction bearings for more than 52 years. The M-R-C CONV type of bearing has been in use for 15 years.
In the design and perfection of workmanship of the M-R-C Conveyor Roll Bearing are incorporated the experience gained in more than half a century in the art of making fine bearings.
MARLIN-ROCKWELL CORPORATION JAMESTOWN, N. Y.

Send for your copy of this 4-page bulletin No. 1529

M-R-C Strom SRB GURNEY BALL BEARINGS

MARLIN-ROCKWELL CORPORATION

Executive Offices: JAMESTOWN, N. Y.



FOR HEAVY DUTY

COMPACT, EASILY INSTALLED TYPE Y COMPRESSOR

Where floor space is limited, and continuous, heavy duty service is required, the Type Y Compressor is ideal. Available with direct-connected, flange-mounted synchronous or squirrel cage motor.

The Type Y Compressor is easy and inexpensive to install, requiring only a simple foundation. No aligning or leveling is necessary.

CP features that assure high efficiency and low maintenance include large area Simplate valves, multi-step capacity regulation, effective inter-cooling, precision bearings and force-feed lubrication.

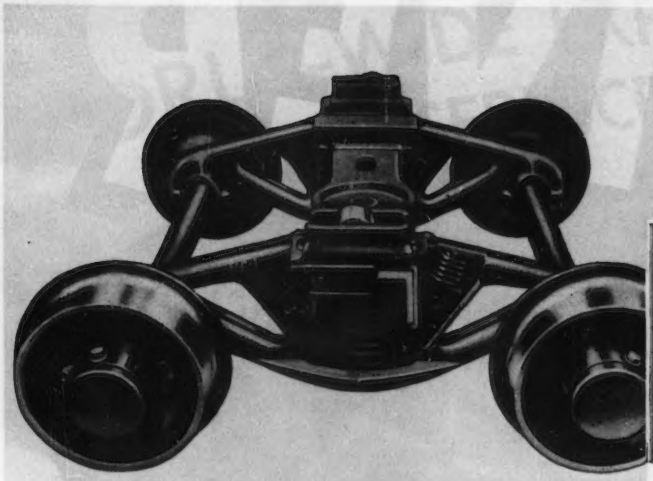
Built in sizes from 75 h.p. to 250 h.p., 501 c.f.m. to 1663 c.f.m.; available also with belted and coupled motors.

Write for Bulletin 766

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 East 44th Street, New York 17, N. Y.

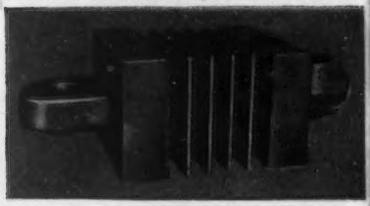
PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES
ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES



The NC-1 Truck climaxes 20 years of intensive research, providing (through the friction control mechanism shown in cutaway) protection to equipment, roadbed and lading with maximum wear life.

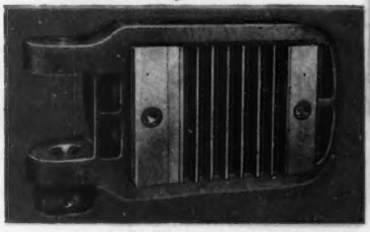
Willison Automatic Couplers save time with maximum safety . . . can be coupled at either end of car or locomotive . . . require no manual assistance. Close coupling eliminates damaging slack, permits high speeds with maximum stability.

NATIONAL *products cut per ton costs!*



National M-230 Rubber-Cushioned Draft Gear for cars operating through rotary dump. Soft initial-action, high-capacity rubber pads provide maximum impact protection, lengthen equipment life. Available in a range of capacities and design variations to fit individual requirements.

Latest example of National's pioneering in better equipment is the NC-1 Truck. Its sweeping advancements over conventional trucks include long soft springs, a friction mechanism—controlling vertical and transverse oscillations, a cast one-piece bolster with large lubricated center connection, and automatic frame alignment. The NC-1 has been designed with the same factor of safety that is required by the Association of American Railroads for full size railroad trucks, and embodies the same features which A.A.R. tests have shown to be essential to produce good riding qualities. For the best in profitable equipment, *always specify National products.*



M-225 Rubber-Cushioned Draft Gear for locomotives and large capacity cars not required to operate through rotary dump. Maximum protection in minimum space.

A-2063

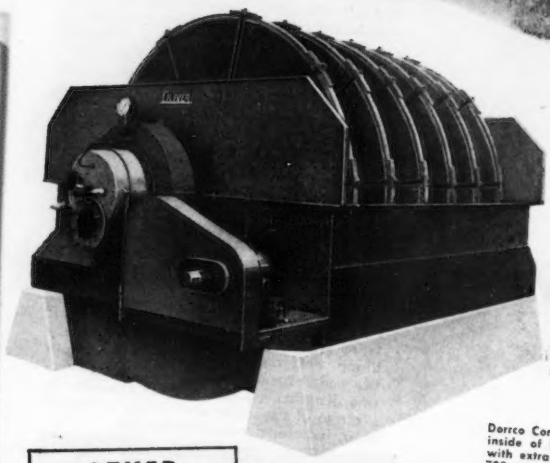
NATIONAL Products FOR TRANSPORTATION AND INDUSTRY Est. 1868

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

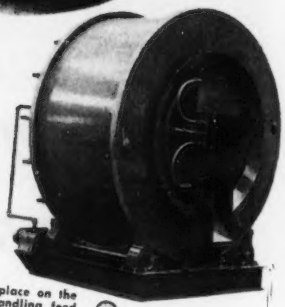
WILLISON AUTOMATIC COUPLERS • NC-1 TRUCKS • DRAFT GEARS • NACO STEEL WHEELS

OLIVER

ORE FILTRATION



American Disc Type Continuous Vacuum Filter, widely used for dewatering, especially flotation concentrates. Large filter area for floor space. Available with divided tank for handling separate products simultaneously. Sizes range from 22 to 2400 sq. ft. of filter area.

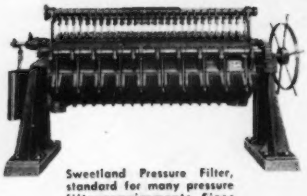


Dorrco Continuous Vacuum Filter. Filtration takes place on the inside of the drum making the filter ideal for handling feed with extra heavy, fast-settling solids. Sizes range from 12 to 783 sq. ft. of filter area.

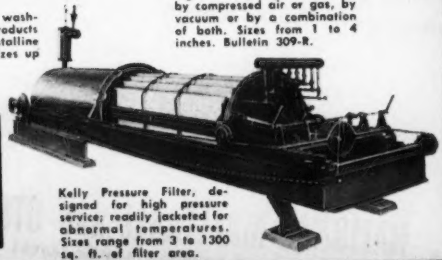
OTHER OLIVER UNITED PRODUCTS

Oliver Horizontal Filter, an excellent washing and dewatering used for many products particularly in the mineral and crystalline classes. All operations are visible. Sizes up to 165 sq. ft. in filter area.

ODS Diaphragm Slurry and Sludge Pump, also excellent for corrosive solutions. Can be used for proportioning. No mechanical linkage. No punchings in diaphragm. Actuated by compressed air or gas, by vacuum or by a combination of both. Sizes from 1 to 4 inches. Bulletin 309-R.



Sweetland Pressure Filter, standard for many pressure filter requirements. Sizes range from 10 to 1044 sq. ft. of filter area.



Kelly Pressure Filter, designed for high pressure service; readily jacketed for abnormal temperatures. Sizes range from 3 to 1300 sq. ft. of filter area.

OLIVER UNITED BULLETINS SHOULD BE ON YOUR DESK

Olivite Acid-Handling Pump — a very efficient and durable pump. Highly resistant to hot and cold chemicals. Sizes: 1¼, 2 and 4 inches. Bulletin 308-R.

WORLD-WIDE EXPERIENCE AND SERVICE FACILITIES

have set a new standard of accomplishment in the BASIC INDUSTRY *of* MINING

As the basic mining industry broadens in scope, as new metallurgical methods are adopted to increase production and lower costs, so the broad experience of Oliver United Engineers meets problems as they arise with unmatched research and development facilities in the field of filtration.

Oliver Filter, the pioneering continuous vacuum filter in this country and now standard all over the mining world for handling cyanide slurries and other metallic and non-metallic products, particularly where washing is of paramount importance. Sizes range from 3 to 790 sq. ft. of filter area.

And, too, as the basic mining industry broadens geographically and as new mining areas are opened up, so the world-wide facilities of Oliver United are prepared to supply the requisite filtration know-how and service wherever ore milling and treatment is carried on.

In both large and small mills not only in the United States but in Canada, Mexico, South America, South Africa and Australia, batteries of Oliver Filters of all types are washing cyanide residues, dewatering flotation concentrates, handling flue dust, tank residues and other products requiring filtration and dewatering. To date, more than 2500 Olivers, Americans, Dorrcos and other types of OUF filters have been installed all over the world.

Two Oliver United facts should always be kept in mind: (1) Oliver ore filtration experience began 45 years ago—an experience assuring you today that the Oliver Filter you buy is the most modern, most efficient and most suitable unit you can obtain. (2) Oliver United has several basic types of filters from which to select—not just one, or two, but several.

New York 18 — 33 W. 42nd St. Chicago 1 — 221 N. LaSalle St.
Oakland 1 — 2900 Glascock St. San Francisco 11 — 260 Calif. St.
Export Sales Office — New York • Cable — OLIUNIFILT

FACTORIES:
Hazleton, Pa.
Oakland, Calif.

OLIVER UNITED FILTERS OUF INC. **INC.**

WORLD WIDE SALES, SERVICE AND MANUFACTURING FACILITIES

CANADA
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Orillia, Ontario

MEXICO & CENT. AMERICA
Oliver United Filters Inc.
Oakland, Calif.

INDIA
Dorr-Oliver (India) Ltd., Bombay

EUROPE & NORTH AFRICA
Dorr-Oliver S. A. Brussels
Dorr-Oliver S.N.a.R.L. Paris
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AUSTRALIA
Hobart Duff Pty., Ltd.
Melbourne

SOUTH AFRICA
E. L. Bateman Pty., Ltd.
Johannesburg, Transvaal

Low Cost Concentration

with the

Humphreys Spiral Concentrator

Bridging the gap between Heavy Media and Flotation, the Humphreys Spiral Concentrator provides a low cost method for recovery of values between 1/8" and 200 mesh.

★ *for* **separation of minerals of different specific gravity in ores at sizes generally minus 10 mesh.**

★ *for* **recovery of liberated values too coarse for flotation.**

★ *for* **recovery of other ore values from flotation tailing.**

★ *for* **recovery of values too fine to be economically treated by heavy-media separation.**

★ *for* **cleaning minus ¼ inch bituminous or anthracite coal.**

Low cost of installation
Low operating costs
No moving parts

Concentrating action of Humphreys Spiral—Note wide black band of concentrate entering upper outlet, which is set for a wide cut, also narrow black band of middling entering lower outlet set for thin cut. In cleaning fine coal, phosphate rock and mica, refuse and middling are discharged from the concentrate ports and cleaned product follows the path shown as tailing.

The installation, operation and maintenance costs of Humphreys Spirals are so low that economical concentration of materials, which could not heretofore be worked at a profit, is now possible. There are no moving parts, no vibration, weight per unit of capacity is low and requires only a light foundation. Floor space per ton treated is very small.

HUMPHREYS SPIRALS are widely used in plant operations in the United States and abroad, ranging from 30 tons to 20,000 tons daily capacity, for concentration of fine iron ore; for concentration of chromite, ilmenite, rutile, and zircon from sands; for concentration of ground ores for recovery of lead, zinc, chromite, copper, barite, mica; for concentration of molybdenum flotation mill tailing for recovery of tungsten; for separation of fine phosphate rock from sand; for cleaning minus ¼ inch coal; for concentration of pyrite from flotation mill tailing; for concentration of fine gold and gold bearing minerals.

A testing laboratory is maintained in Denver by the Engineering Division of The Humphreys Investment Company. Results obtainable in a full size plant may be determined by tests of a representative sample of minerals or coal weighing 300-500 pounds.

THE HUMPHREYS INVESTMENT COMPANY
ENGINEERING DIVISION
914 First National Bank Building • Denver 2, Colorado

Manufacturing and Sales Agents
SWEDEN: Sala Maskinfabriks A-B, Sala
AUSTRALIA: John Carruthers & Co. Pty. Ltd., Edgecliff, N.S.W.
BOLIVIA: Mauricio Hochchild S.A.M.I., La Paz
SOUTH AFRICA: Edward L. Bateman (Pty.) Ltd., Johannesburg

PRODUCTION LINE...with 8 million links

● Trucks on the move! More than 8 million of them throughout the United States — a bulwark of security in this time of crisis.

Ever think of them as a vast mobile production line which carries, one time or other, nearly every single thing we need and use, both for daily living and for National Defense?

It's a line that starts deep in the forests... in the mines and quarries ... and in the rutted mud of the oil fields. It keeps raw materials flowing to plants and factories... speeds the finished products of American industry to consumers and the armed forces.

It stretches from coast to coast... from the Dominion to the Gulf ... runs through the largest cities... reaches into the smallest townships. Last year it carried 8.3 billion tons of freight, more than all other transport systems put together.

All along that line you'll find sturdy Mack trucks doing double duty — working longer hours, carrying bigger loads. Meeting emergency conditions with all the *extra* strength and stamina, *extra* performance and *extra* dependability for which Macks have long been famous.

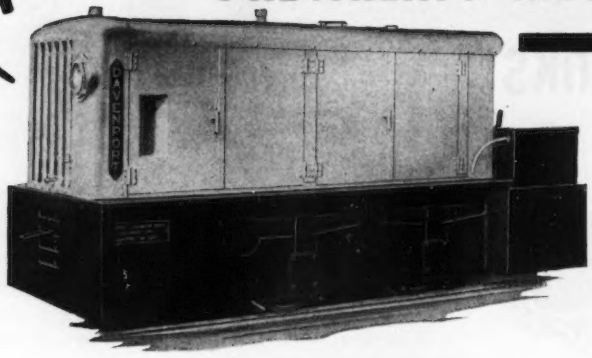
Now — in this period of uncertainty — Mack owners realize what it means in *long-lasting* economy and reliability to have trucks that are "Built Like A Mack".

Mack TRUCKS

...outlast them all

Mack Trucks, Empire State Bldg., New York 1, New York. Factories at Allentown, Pa.; Plainfield, N. J.; Long Island City, N. Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.

MINING PROFITS —depend upon EQUIPMENT ECONOMIES as well as PREVAILING METAL MARKETS



AT LEFT

A 7-Ton, Mine Type Locomotive of 18" Gauge, 60" Overall Height from top of rails; equipped with Caterpillar D-311 Engine, Water Wash Muffler and Exhaust Diffusor; Twin-Disc Hydraulic Coupling; 4 Speed Transmission both Forward and Reverse. Can be provided Explosion Proof where desired.

Give sober thought to whether your rail haulage is an AID or a DETERRENT in the creation of PROFITS. For getting the maximum tonage moved — promptly — and at LOWEST TON-MILE COSTS entrust your rail haulage to Davenport or Porter Locomotives — designed and built to meet YOUR particular haulage requirements — the Locomotives that more than pay their way.

DAVENPORT LOCOMOTIVES

Available in
STEAM
FIRELESS
GASOLINE
DIESEL
with
ELECTRIC
or HYDRAULIC
or MECHANICAL
DRIVE

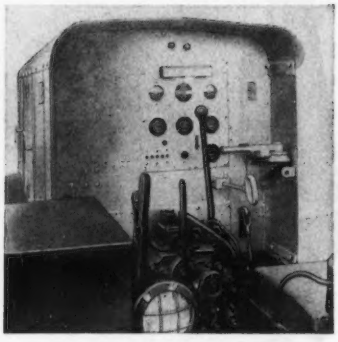
PORTER Davenport Built LOCOMOTIVES
Established 1866

If it's a DAVENPORTER it's the BEST

ANALYZE YOUR NEEDS

Davenport engineers will be glad to receive from you a description of your haulage operating conditions and range of work to be done. They will analyze and submit recommendations as to the best size and type of locomotive for your use — without obligation on your part.

FITTED POWER assures TOP RESULTS



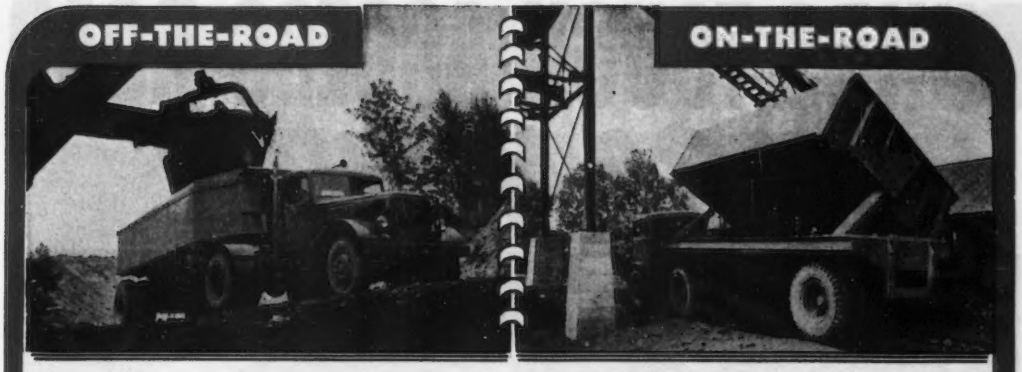
The controls of the Locomotive illustrated above are readily accessible and positive; all essential operating factors are accurately recorded on easily seen gauges. Thus ample and responsive power is always available.

Complete Information on Request

DAVENPORT LOCOMOTIVE Division
DAVENPORT BESLER CORPORATION
DAVENPORT IOWA, U.S.A.

PORTER Davenport Built LOCOMOTIVES Established 1866

EXPORT OFFICE • 50 CHURCH STREET, NEW YORK 7, NEW YORK, U. S. A. CABLE ADDRESS "BROSITES"



GENERALS

go in—get the load—carry it out and over-the-highway

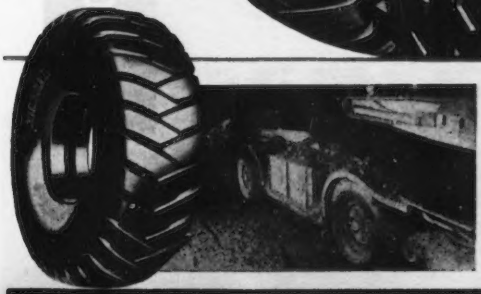
FASTER! EASIER! At Lower Cost!

Pile on the tons. The General L. C. M. is built to move heavy loads out over jagged surfaces without cuts, bruises or snags.

THE GENERAL L.C.M.

Move more tons over the road on this tough, dependable General H.C.T. Longer wearing, safer running, quicker stopping.

THE GENERAL H.C.T.



GENERAL UNDERGROUND MINING TIRE

Extra thick side-walls and shoulders resist snags, cuts and bruises. Definitely gives more hours of uninterrupted work.

SPECIFY GENERAL TIRES ON YOUR NEW EQUIPMENT

BUILDS TOUGH ACCESS ROAD *IN 30 MINUTES*

"BIG RED" BLASTS ACCESS ROAD THROUGH THICK WOODS near Bangor, Pennsylvania. At mine this brute power will strip overburden economically.

international's Big Red TD-24 clears 200-foot road to coal mine site in half hour

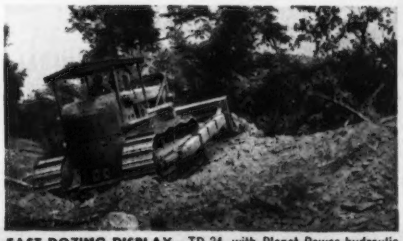
Slashing and dozing its way through uphill woods, an International TD-24 carved out a 200-foot access road in thirty minutes at the J. H. Beers coal mine near Bangor, Pa.

Now the Big Red Champ is on the stripping job, dozing big loads each pass to a 2½-cubic-yard shovel loading once a minute.

It takes the guts of a "Champ" to dig in and put out the big loads. That's how the TD-24 performs, with 148 maximum horsepower at the drawbar.

Get all the news on this great crawler. Ask your International Industrial Distributor for all the facts, and find out what he offers in service for the years ahead.

INTERNATIONAL HARVESTER COMPANY
CHICAGO 1, ILLINOIS



FAST DOZING DISPLAY—TD-24, with Planet Power hydraulic steering and quick forward-reverse shift, speeds up dozing cycles and makes fast work of road building.

INTERNATIONAL

INTERNATIONAL HARVESTER

POWER THAT PAYS

Just the right balance between *Precision* and *Economy!*

ROLLWAY Tru-Rol ROLLER BEARINGS

Rollway's Tru-Rol cylindrical roller bearings fill a well-defined need . . . afford the design engineer much wider latitude in his choice of means to balance performance and reasonable cost . . . help to ease the pinch on critical materials.

A steel-cage bearing in the steel-cage cost range, TRU-ROL boasts a trueness and precision of roll approaching that of bronze-separator types. That's because of the exclusive Rollway guide-lip . . . an ingenious, low-cost feature that prevents roller-skewing with all its train of evils, such as sliding friction, end-rub, power losses and excessive wear. Investigate TRU-ROL's outstanding record before you specify bearings in medium price range.

Engineering Service

Forty years of specialized bearing experience are at your service in the solving of particular bearing problems. Just ask for a Rollway engineer to consult with you: No cost. No obligation.

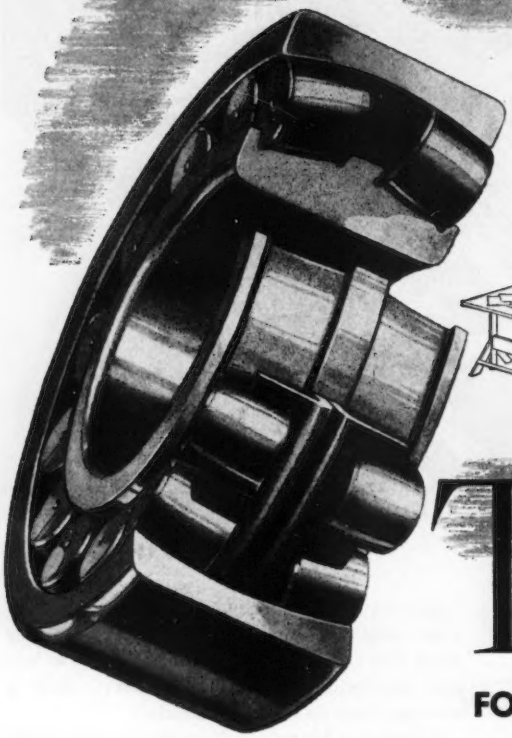
SALES OFFICES

Philadelphia • Boston • Pittsburgh • Cleveland • Detroit
Chicago • Houston • Los Angeles

ROLLWAY BEARING CO., Inc.
Syracuse 4, N. Y.

DESIGN ENGINEER
MINING EQUIPMENT

SKF
BEARING
ENGINEER



TEAM

FOR EFFICIENCY AND ECONOMY

Over the years, SKF engineers have worked closely with engineers and designers in every field of industry. This co-operation, this *team-work*, has helped industry minimize friction in all types of equipment from the smallest motors to the largest blooming mills. Whether you are designing new equipment or looking for efficient, economical replacement bearings, look confidently to SKF for expert, proved advice. Depend on SKF to help you put the right bearing in the right place. 7270-D

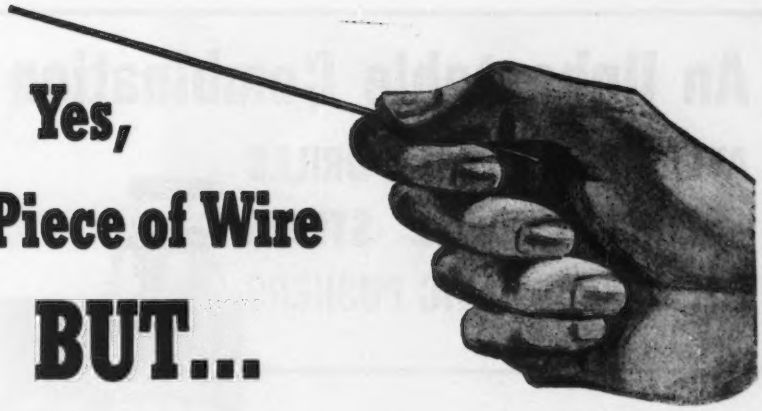
SKF
BALL AND ROLLER BEARINGS

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

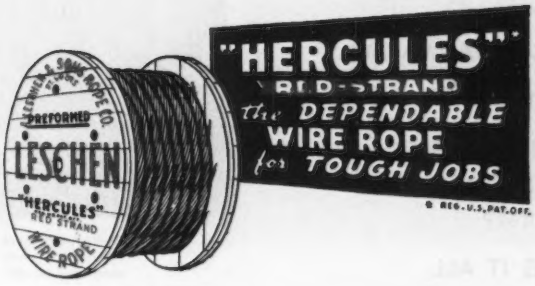
integrity • craftsmanship • metallurgy
tolerance control • surface finish
product uniformity • engineering service
field service

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.—*manufacturers of* SKF *and* HESS-BRIGHT *bearings.*

Yes,
Just a Piece of Wire
BUT...



upon its quality and fabrication depends the kind of wire rope service you will get.



If this wire goes into a rope of the 6 x 19 Seale Construction with a fiber core, it will be just one of 114. But if it is a "HERCULES" (Red-Strand) Wire Rope, *every* one of the 114 wires will have been rigidly tested to make sure that it met, fully, our exacting standards as to *all* essential properties. Furthermore, the rope will have been designed and fabricated according to the most advanced methods of manufacture.

Only by the strict adherence to such principles can the highest quality in wire rope be produced — *consistently*. It is never a matter of chance.

Because of the exacting care and long experience always used in making "HERCULES" (Red-Strand) Wire Rope, you can depend on it for safe and economical service. As it is made in a wide range of construction — either Preformed or Non-Preformed, there is in this one grade, a "Right Rope" for any heavy duty job.

MADE ONLY BY

We Invite Your Inquiries

A. LESCHEN & SONS ROPE CO. 5909 KENNERLY AVE. • ST. LOUIS 12, MO.

ESTABLISHED 1857

New York 6 · Chicago 7 · Birmingham 6 · Houston 3 · Denver 2 · Los Angeles 21 · San Francisco 7 · Portland 9 · Seattle 4

An Unbeatable Combination . . .

ATLAS DIESEL ROCK DRILLS
COROMANT DRILL STEELS
ATLAS PNEUMATIC PUSHERS

Drilling with Rock Drill RH-655W using Pneumatic Pusher BMK41A2 and Coromant drill steels

Advantages:

- LIGHT WEIGHT
- EASILY MOVED
- FEWER STEEL CHANGES
- MORE DRILLING TIME AVAILABLE
- HIGHER OUTPUT
- SAVINGS IN INITIAL COST, COMPRESSED AIR CONSUMPTION ROCK DRILL UPKEEP
- ONE DRILL DOES IT ALL

For all kinds of underground operations this is the real universal type of rock drill. When used in combination with a pneumatic pusher and Coromant drill steels, it constitutes a most efficient drilling outfit in drifting, tunneling, and any underground working involving drilling of horizontal or inclined holes, as in shrinkage stoping, sub-level caving, etc. When required for shaft sinking, it is available with a weight.

Our Technical Service Staff Available at all Times

COPCO Pacific Ltd.

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and in CANADA

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MONTREAL TORONTO KIRKLAND LAKE PORT ARTHUR VANCOUVER

Peak Performance

achieved with Du Pont "NITRAMEX" NO. 2 in Tough Taconite Shooting Program

Close-up of Minnesota open pit shows well-spread breakage from "Nitramex" No. 2 blast. Slower development of pressure—a characteristic of "Nitramex" No. 2—produces a better spreading action . . . assures uniform fragmentation . . . speeds work and decreases costs.

Right from the start of this long-range program, Du Pont "Nitramex"* No. 2 has delivered top performance for the customer . . . this meant better breakage, which in turn meant lower production costs. Fragmentation has been consistently good throughout the job, allowing operations to proceed economically and on schedule.

The high strength of "Nitramex" No. 2, coupled with its spreading action, is ideally suited to blasting taconite. It frequently permits increased drill-hole spacings—cutting drilling costs without sacrificing breakage or shovel efficiency.

The safety features of "Nitramex" No. 2 are especially important. It is insensitive to open flame, friction or even high-powered rifle shots. It is easily and safely detonated with a "Nitramon" Primer, using Primacord. And, since it contains no nitroglycerin, "Nitramex" No. 2 cannot cause headaches.

Any Du Pont explosives representative will be glad to give you complete information on Du Pont blasting products for safer, more economical ore production. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington 98, Delaware.

*Reg. trade-mark for ammonium nitrate blasting agent

Economical removal of overburden depends on degree of fragmentation. The extra strength of "Nitramex" No. 2 provides excellent breakage needed . . . even in very hard taconite.

DU PONT "NITRAMEX" NO. 2

Not currently for sale in western states

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

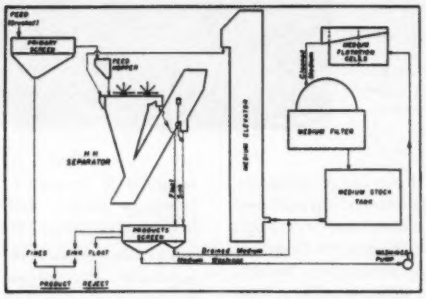
MORE PRODUCTION WITH

H H S F Process

SINK FLOAT

- INCREASES METAL RECOVERIES
- LOWERS CONCENTRATING COSTS
- SAVES MAN HOURS
- INCREASES METAL RESERVES

USED BY LEADING PRODUCERS



COMPLETELY CONTROLLED HEAVY DENSITY CONCENTRATION

MORE EFFICIENT S F **MORE ECONOMICAL**

- Rejects coarse waste without grinding it.
- Produces coarse market concentrate.
- Permits nonselective mining.
- Treats metallics and nonmetallics
- Treats mine ores, dumps, fill, development ore.
- Serves existing and new installations.
- Reduces Capital and Operating Costs.

THE SINK AND FLOAT CORPORATION

100 PARK AVE NEW YORK 17, NEW YORK

Back of Your New GM Diesel Power

3 BIG SERVICE EXTRAS

We want every purchaser or prospective purchaser of one of our engines to know how his local GM Distributor and Dealer, with their factory-trained servicemen, stand back of the product. They in turn are backed by the knowledge that Detroit Diesel supports them strongly in their adherence to this policy.

1. *Installation Inspection:*

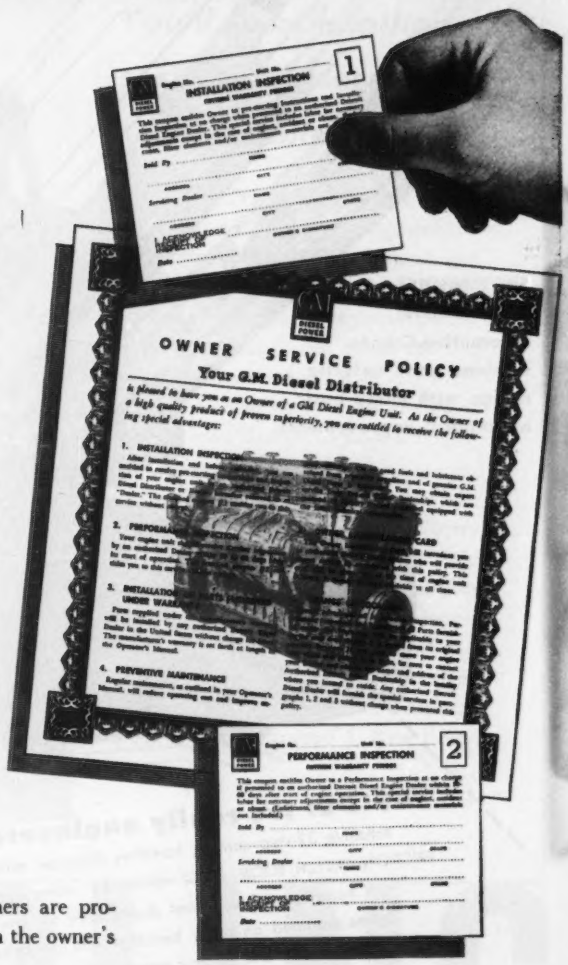
The GM Diesel serviceman inspects and checks the engine without cost to the owner; whenever possible this is done before the engine is put to work. He explains how to successfully operate the engine and the "preventive maintenance" necessary for best results in days to come.

2. *Performance Inspection:*

From thirty to sixty days after the engine has begun its job, another inspection is provided without charge. The GM Diesel serviceman makes any adjustments that may be required and tunes up the engine to its best performance.

3. *Owner's Service Policy:*

Besides the above inspections, GM Diesel owners are protected by the exceptional warranty mentioned in the owner's service policy.



ANSWER THE CALL CIVIL DEFENSE

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES...Up to 275 H.P. **DETROIT 28, MICHIGAN** MULTIPLE UNITS...Up to 800 H.P.

GENERAL MOTORS

DIESEL BRAWN WITHOUT THE BULK

GM GENERAL MOTORS DIESEL POWER

OUTSIDE: It's a beauty Extra-heavy Streamlined MONITOR-TYPE CAB! 360° visibility! All controls conveniently located; all machinery fully protected from the weather, yet accessible. New CLEAR VISION BOOM. 14 inch safety clearance between car body and upper works.

BROWNHOIST Diesel Electric Locomotive-Cranes combine good exterior design with many basic mechanical improvements.

INSIDE: It's really engineered New DYNAMATIC CLUTCH gives smooth, sensitive 32-step control, banishes slippage, eliminates torsional impulse and vibration. Safe FRICTION CLUTCH BOOM HOIST driven by worm and wheel in oil bath. Twin-barrelled, extra-large boom-hoist drums take all line in one layer. New Wide-faced Hoist Drums mounted on roller bearings with air cylinder mounted within the drum. ELECTRIC ROTATION and electric travel reduce maintenance to a minimum. Optional features include 8-WHEEL CHAIN DRIVE for increased drawbar pull and TWIN ENGINE DRIVE where greater tractive effort is required.

147

BROWNHOIST

INDUSTRIAL BROWNHOIST CORPORATION, BAY CITY, MICHIGAN

DISTRICT OFFICES: New York, Philadelphia, Cleveland, Chicago, San Francisco, Canadian Brownhoist, Ltd., Montreal, Quebec. AGENCIES: Detroit, Birmingham, Houston, Los Angeles

WIRE ROPE

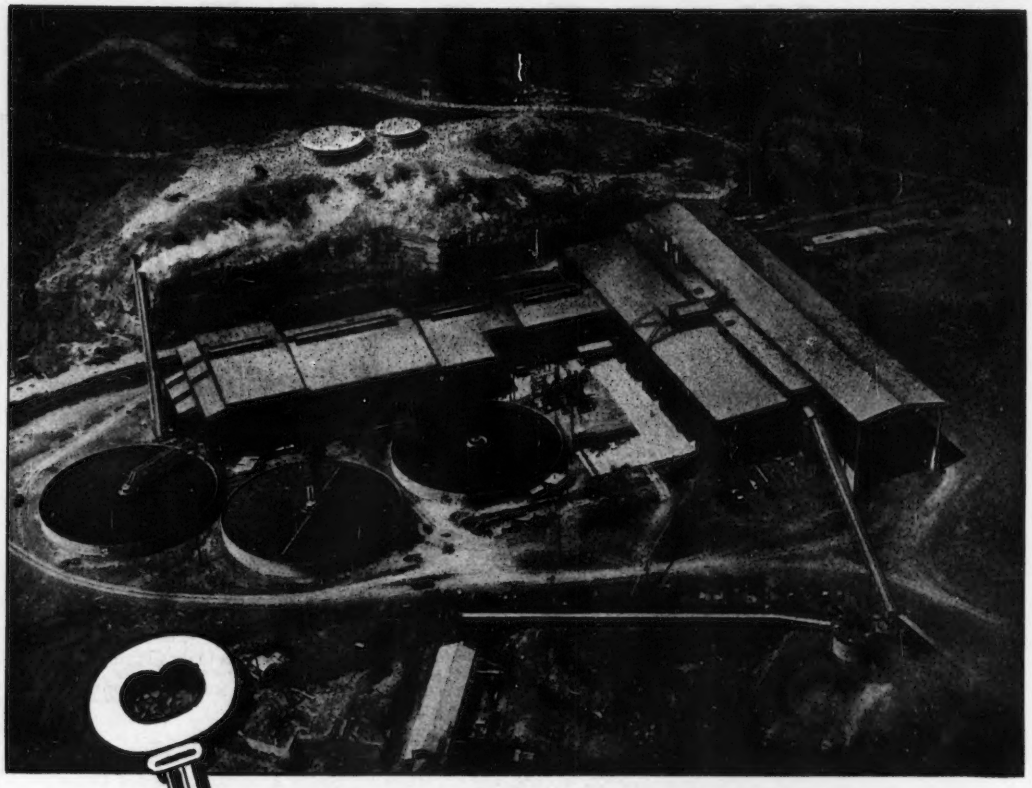
You'll get smoother, cost-saving service with Roebling

"BLUE CENTER" STEEL wire rope is an exclusive Roebling development. Its high resistance to abrasion, shock and fatigue spells long life. In addition, Roebling Preforming gives you a rope that is easy to handle... has better spooling qualities... reduces vibration and whipping. This combination makes Preformed "Blue Center" Steel Wire Rope a top performer on the job.

Roebling makes a complete line of wire rope... there's a construction for every installation. Have your Roebling Field Man help choose the *right* rope for your equipment. Get his advice on the correct use and maintenance of wire rope. It is based on performance records on thousands of installations. John A. Roebling's Sons Company, Trenton 2, New Jersey.

ROEBLING

Atlanta, 934 Avon Ave ★ **Boston**, 51 Sleeper St ★ **Chicago**, 5525 W. Roosevelt Rd ★ **Cincinnati**, 3253 Fredonia Ave ★ **Cleveland**, 701 St. Clair Ave, N.E. ★ **Denver**, 4801 Jackson St ★ **Detroit**, 915 Fisher Building ★ **Houston**, 6216 Navigation Blvd ★ **Los Angeles**, 216 S. Alameda St ★ **New York**, 19 Rector St ★ **Odessa, Texas**, 1920 E. 2nd St ★ **Philadelphia**, 230 Vine St ★ **San Francisco**, 1740 17th St ★ **Seattle**, 900 1st Ave, S. ★ **Tulsa**, 321 N. Cheyenne St ★ Export Sales Office, **Trenton, N. J.**



"KNOW HOW" THE KEY TO SUCCESSFUL PERFORMANCE

Aerial view of a wet process plant at Portland, Colorado, designed and constructed by the Stearns-Roger Manufacturing Company according to specifications of the Ideal Cement Company. This plant has a daily production capacity of 4,000 barrels.

Stearns-Roger construction facilities are adequate for any size project—and round out a service which "begins at the drawing board." The "know how" required in projects of this type enables Stearns-Roger to take undivided responsibility in a complete service including: engineering, designing, manufacturing, construction.

Stearns-Roger

DENVER, COLORADO

Rotary Bit Drills 4500′ In Potash Ore

Satisfactory results are reported in the rotary drilling of hard potash ore in southeastern New Mexico, as 4500 feet of drilling is being obtained in langbenite per average bit life. Jeffrey A-6 Drills equipped with Kennametal Tungsten Carbide Insert Rotary Bits, 1½" in diameter, are used.

•

Iron Ore Rotary Drilled

In one operation in Minnesota, an unusual use of Kennametal Tungsten Carbide Rotary Drill Bits is being made to drill in the overburden in recovering low grade ore. The boring is done horizontally. Speed and mobility over the churn drilling method are the advantages reported.

•

108′ Holes In Gypsum Drilled By Rotary Bit

A large gypsum mine operator in Virginia reports that holes are now being drilled successfully to a depth of 108 feet by the use of rotary auger-type equipment, supplementing core drilling equipment for long hole drilling. Advantages are: Speed, freedom from water and dust, easy mobility. Kennametal 1⅞" Tungsten Carbide Bits and scroll-type auger are used.

•

Structural Bit Gives Big Ore Samples

A six-point "Chopping Bit" used on the Mesabi Range to determine quality of formation is reported to cut cost 50% to 70% in two instances where it has been used. A big feature is that it produces large, easy-to-analyze chunks of ore. It is set with 6 Kennametal Tungsten Carbide Inserts.

Kennametal Rock Bits DRILL FASTER

The Kennametal Multiple-Point Rock Bit offers 10% to 12% faster drilling speeds under average conditions due to its "3-point" construction and exceptional clearance for cuttings.

Single blade construction enables the Kennametal "Chisel-Type" Bit to give faster drilling speed, longer service life in hard, solid, abrasive rock.

After more years of experience than any other American manufacturer in the development of tungsten carbide rock bits, Kennametal has produced these modern bit designs that put the emphasis on drilling speed.

"Three-point" construction is offered in the Kennametal multiple-point bit to give additional drilling speed (10% or more in many cases) where the use of multiple-point bits are necessary. Where conditions permit, such as in solid hard drilling, the chisel-type bit gives still higher rates of penetration.

Kennametal Bits offer long life because they feature inserts of Kennametal tungsten carbide, the carbide used in more mining bits than any other carbide in the world.

Special construction features are: Good clearance for free removal of cuttings; easy reconditioning.

For dependable low cost results, use Kennametal "Insert-Type" Rock Bits.

Detailed information on request by writing: Kennametal Inc., Latrobe, Pa.

KENNAMETAL inserts make the BIG difference

Kennametal inserts make the BIG difference in every drilling job as they feature long wear and high resistance to shock. They are produced according to special Kennametal processes that differ from any others in the world. They are dependably more uniform in quality. Kennametal's Nevada Scheelite Mine produces much of the tungsten used in their manufacture.

KENNAMETAL®

BITS FOR ROTARY AND PNEUMATIC DRILLING IN METAL AND NON-METALLIC MINERAL MINES

ROCK BITS • DRAG BITS • CORE BITS • DRILL BITS FOR SPECIAL JOBS

ADVERTISEMENT

Mining Tires
exactly fitted for their work

When we say "exactly fitted" we mean a mining tire built for the toughest conditions OFF THE ROAD, while giving a smooth long-wearing roll on the highway.

This *off-the-road* and *on-the-road* problem has now been solved. Both mining requirements have been fully met and mastered.

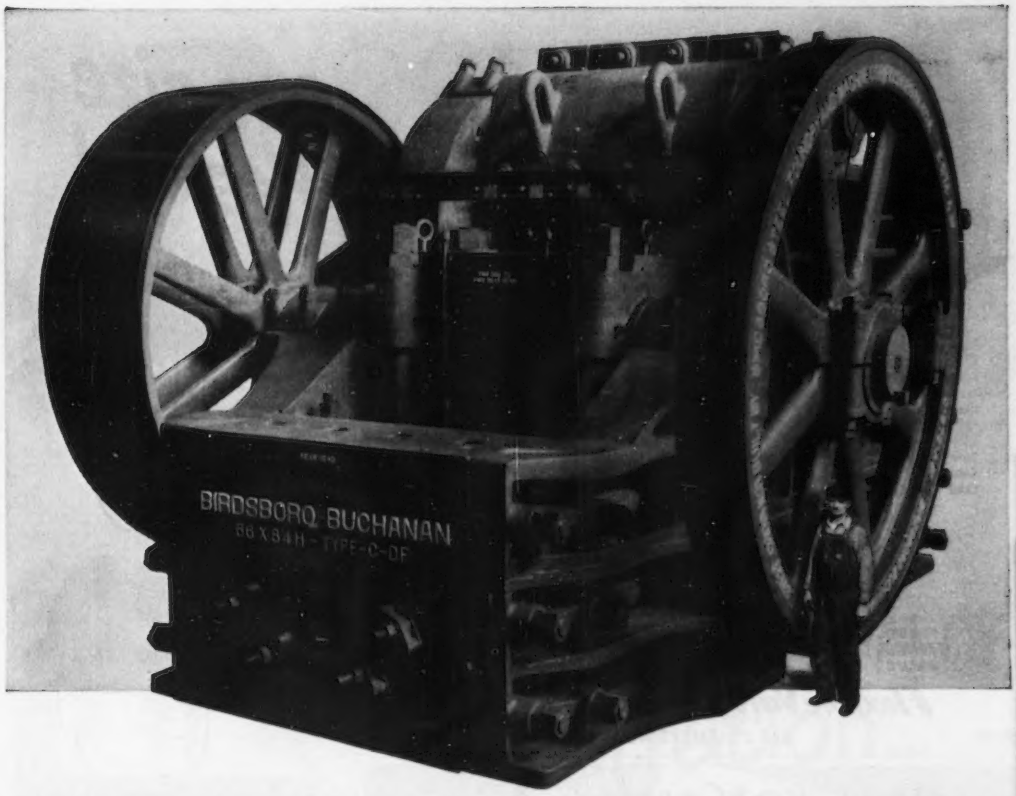
These are the facts about the U.S. ROYAL FLEETMASTER which can contribute to a radical reduction in your tire costs.

These U. S. Royal Fleetmaster facts add up to *reduced tire costs — increased efficiency — lower maintenance!*

- ★ ***70% Deeper Traction Tread!*** (For complete holding penetration OFF THE ROAD! With long-wearing smoothness on the *highway*)
- ★ ***Tougher, Stronger Carcass!*** (Permitting even greater additional safe mileage with more recaps)
- ★ ***Special Tread Compounds!*** (Utmost in cut and chip resistance)
- ★ ***Round-Moulded Carcass!*** (Natural inflated shape reduces distortion strain)
- ★ ***Thicker Under-Tread!*** (Your bed-rock for super-traction and mileage)

A phone call does it! **To your nearest U. S. Royal Distributor! He's listed in the Classified Telephone Book!**

UNITED STATES RUBBER COMPANY



THE LARGEST DEEP FRAME CRUSHER EVER BUILT

OFFSET TOE LUGS THAT NEVER WEAR OFF—

a patented Birdsboro development and standard equipment on all Birdsboro deep frame crushers. They are offset from the face of the jaw plate and allow 100% or more useful plate life.

Canadian Representative & Manufacturer
JOHN INGLIS CO., LTD.
TORONTO, CANADA

World-Wide Agent Representation. Contact home office for nearest representative.

Designed and Manufactured by

BIRDSBORO

One of the largest crushing jobs ever attempted with a jaw crusher has been solved with this giant BIRDSBORO-BUCHANAN 66″ x 84″ deep frame jaw crusher. With this large receiving opening this crusher will take the feed from a 5 cubic yard shovel crushing the material down to 10″ to 12″ product at the rate of approximately 1,000 tons per hour. Immense power, high strength and long life have been built into this crusher to provide continuous and dependable crushing service. When you have a crushing problem, regardless of the size of your operation, it will be to your economical advantage to call in Birdsboro engineers.

BIRDSBORO
STEEL FOUNDRY & MACHINE CO.
Birdsboro, Penna.

BIRDSBORO BUCHANAN JAW CRUSHERS

Designers and Builders of:
Crushing Machinery • Rolls • Steel Mill Machinery
Hydraulic Presses • Special Machinery • Steel Castings

if it Flows . . .

Asbestos
Cement
Clay
Fuller's Earth
Lime
Magnesia
Phosphate
Potash
Salt
Sand
Coal

Flex-Valve it

FLEX-VALVE is the ideal choice for handling such materials as those listed—either dry or in suspension—at temperatures up to 210 deg.

Resists both abrasion and corrosion; eliminates clogging, plugging, building up; absorbs vibration and misalignment.

Open—it's as free of obstruction as the pipe itself. Closed—it's bubble-tight and it closes tight on all of these materials.

Available in either hand or air operated types in sizes from ½ to 12 in.

Users have found FLEX-VALVE to be the low-cost solution to tough valving problems. If your present valves aren't 100% effective, take a look at this one. Catalog 455 gives details.

FLEX VALVE

Flexible Valve Corporation

7885

445 COMMERCIAL AVE. • PALISADES PARK, N. J.

One size fits all!

HARD BOILED*

HAT USERS SAVE MONEY...

Reduce hat inventories. Headbands sized in one minute. Save Time! Entire headband assembly removed in six seconds...replaced in six seconds. Shapes to the head *instantly* for "fishing hat" comfort.

Stronger-than-steel molded Fiberglas crowns are the safest ever built; available in your choice of vivid, *permanent* colors and white or black.

WRITE FOR FREE COLOR CIRCULAR

EVERYTHING BULLARD IN SAFETY — HARD BOILED *T. M. Reg.

Distributors in principal cities

E. D. BULLARD COMPANY

275 EIGHTH STREET, SAN FRANCISCO, CALIFORNIA

Pick this Lightweight for Heavyweight drilling!

Like all Acker Drills, this lightweight husky was designed and built to operate under the most rugged conditions.

If you are looking for a quality drill that will give you years of trouble-free operation—*you want the Acker Teredo.*

Over 30 years of experience in the design and manufacture of drilling equipment is the big reason why Acker Drills stand-up year after year, job after job. *Write for Bulletin 33.* EM

The NEW ACKER TEREDO DRILL

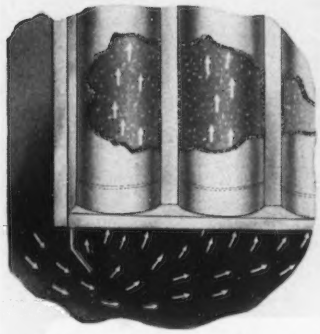
ACKER DRILL CO., INC.

SCRANTON 3, PA.

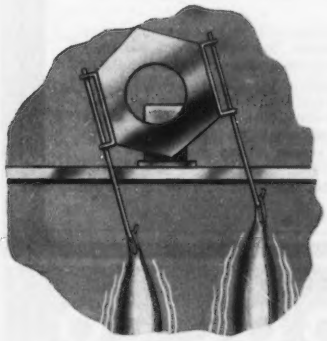
Tubes are rapidly replaced by one man working from the clean air side and condition is readily determined without removing parts

Tubes are expanded tightly into cell plate to prevent dust leakage. Compartments can be isolated for maintenance while balance of Collector operates.

Tubes are compact, easy to store and ship. They are never under tension — never in contact with metal that might abrade or corrode the fabric.



Few working parts give continuous service with a minimum maintenance for heavy duty installations in smelting, rock product and mining applications.



The simplified mechanical method of shaking a Dustube results in efficient, effective tube cleaning.

dustube's

DUST AND FUME COLLECTION BY Filtration... COSTS YOU LESS

You pay less for dust and fume recovery when you use a Dustube. By combining the proven efficiency of cloth filtration with a unique operating simplicity, Dustube Collectors remove dust thoroughly at low cost. Uniform recoveries approaching 100% are commonplace and the collected material can be reprocessed without de-watering, filtering or drying.

Dustube Collectors are custom designed for the metallurgical industry. They are particularly suitable for the recovery of values in gases from roasters, sintering machines, induction furnaces, and refining operations. Through the use of synthetic filtration fabrics, they will efficiently and economically handle hot and/or corrosive gases.

It will pay you to investigate the many cost-cutting advantages of Dustube Collectors described on this page. Write for complete information today.

American WHEELABRATOR & EQUIPMENT CORP.
438 S. Byrkit St., Mishawaka 24, Indiana

dustube COLLECTORS

CUT DRILLING COSTS!!!

BLAST HOLE AND COAL RECOVERY DRILLS

Heavy
Rugged
Powerful

● McCarthy Self-Propelled Horizontal Blast Hole Drills get in and out of tight quarters quickly; adjusts on four individual leveling jacks for proper drilling heights. Excellent for low level work.

● Truck Mounted Horizontal McCarthy Drills are breaking drilling records everywhere! All necessary equipment is carried with the unit — out of the mud at working level!

● Here's a Vertical McCarthy Unit on a Half-Track. Compact construction makes McCarthy Drills perfect for all mountings . . . truck, half-track, cat, jumbo or other special rigs.

● McCarthy Coal Recovery Drills are revolutionizing both deep and strip mine operations. As the auger moves in, steady streams of clean coal are pulled out without touching the overburden. Average daily output ranges from 15 to 50 tons per man per shift. Many models are available. The machine illustrated above is equipped with a 36-inch auger, reversible hoist and Lump Dust Hood.

HYDRAULIC FEED

Instantaneous control selects any speed up to 8 feet per minute.

FINGER-TIP CONTROL

Determines rotating speed of auger.

McCARTHY DRILLS

● If you haven't already seen a McCarthy at work, we suggest you see one quick!

These rugged, powerful units have gained universal acceptance as the most efficient machines ever made for drilling blast holes. Furnished with gasoline, electric or diesel power.

Extra heavy construction relieves you of maintenance troubles. They're versatile, fast, economical machines capable of 50% more productive service than any drill you might now be using!

Write Salem Tool today for full facts. Also ask about McCarthy Coal Recovery Drills — the machine that's being acclaimed in so many trade journals for its remarkable ability to reduce mining costs.

DRILLING EQUIPMENT SINCE 1901

●

MANUFACTURED BY

SALEM

THE SALEM TOOL CO.

8035 ELLSWORTH AVE. SALEM, OHIO, U. S. A.

Non-metallic melting? LECTROMELT* has the answers!

Designed to solve your production problems—

For smelting and refining operations, so many variables enter into each problem that Lectromelt plans your furnace or furnace components to meet specific requirements. Electrode controls, for example, are designed for the individual installation. Automatically or manually operated, they make possible finely accurate adjustments.

Built to keep you in production—

Because they're built for long, low-cost operation. Rugged construction is combined with micro-accurate control. Electrical equipment and substations are built to withstand tremendous overloads.

More than a million and a half kilowatts of installed capacity promise that Lectromelt engineers have the answer to your smelting problems. Write for our booklet to Pittsburgh Lectromelt Corporation, 222 32nd Street, Pittsburgh 30, Penna.

Write for your free copy of Lectromelt's booklet, "Moore Rapid Lectromelt Furnaces for Smelting and Refining Operations."

*REG. T. M. U. S. PAT. OFF.

WHEN YOU MELT... MOORE RAPID Lectromelt

PIT AND QUARRY MEN AGREE . . .

You can do the Job BETTER, SAFER, FASTER with PRIMACORD®

PRIMACORD produces a powerful detonating wave which travels at approximately 4 miles per second throughout its length. It acts as the detonating agent for all holes in the shot.

The infinitesimal time lag between holes and rows of holes permits planned rotation firing, relieves burden. The powerful detonation of each portion of each charge produces more work from your explosives.

Primacord is insensitive to stray electrical currents —cannot be set off by friction, sparks or ordinary shock.

Add to this the ease of handling, simplicity of hook-up, and high tensile strength . . . you'll see why it is the almost universal choice of pit and quarry men.

WIRE COUNTERED PRIMACORD. Armored with closely stranded brass wire, Wire Countered Primacord is the answer where deep, ragged holes and high abrasive conditions are encountered. The wire sheath increases tensile strength to 220 lbs. Weight per 1000-foot spool is 35 lbs.

PLASTIC REINFORCED PRIMACORD. Use it for extremely deep, wet holes, river crossings, or wherever water is a problem. It is also resistant to acids commonly encountered. Although Plastic Reinforced Primacord weighs only 22 lbs. per 1000-foot spool, its tensile strength is 250 lbs.

REINFORCED PRIMACORD. Depend on it for use in deep holes where extra tensile strength (160 lbs.) or resistance to abrasion are desirable. Tough, but resilient and easy to handle, it is gaining in popularity for general use. 1000-foot spool weighs 20 lbs.; tensile strength 160 lbs.

PLAIN PRIMACORD. For shallow holes, surface trunkline use and other applications where abrasive and other rugged conditions are not considerations. 1000-foot spool weighs 19 lbs., tensile strength 113 lbs.

P-55

Users of Primacord agree that there is no substitute for its general excellence. Consult your explosives supplier for complete information, or write to us direct.

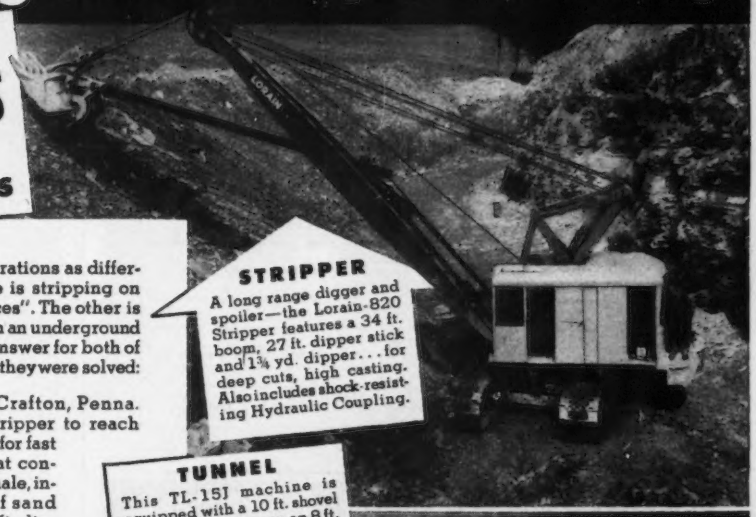
THE ENSIGN-BICKFORD COMPANY
Simsbury, Connecticut

PRIMACORD®-BICKFORD DETONATING FUSE

Also Ensign-Bickford Safety Fuse — Since 1836

SWING *HIGH*...SWING *LOW*—
LORAINS *work where you want to dig*

HOW LORAINS SOLVED 2 PROBLEMS



▶ Here are two mining operations as different as day and night. One is stripping on top in the "wide open spaces". The other is working in close quarters in an underground mine. Lorain had the best answer for both of these problems! Here's how they were solved:

HADDOCK COAL CO., Crafton, Penna. selected a Lorain-820 Stripper to reach "high, wide and handsome" for fast removal of overburden that consisted of slate and yellow shale, interspersed with layers of sand rock. 34 ft. boom with 27 ft. dipper stick and 1¾ yd dipper gave long range digging and spoiling—to dig deeper cuts and cast material higher onto farther spoil banks.

STRIPPER
A long range digger and spoiler—the Lorain-820 Stripper features a 34 ft. boom, 27 ft. dipper stick and 1¾ yd. dipper... for deep cuts, high casting. Also includes shock-resisting Hydraulic Coupling.

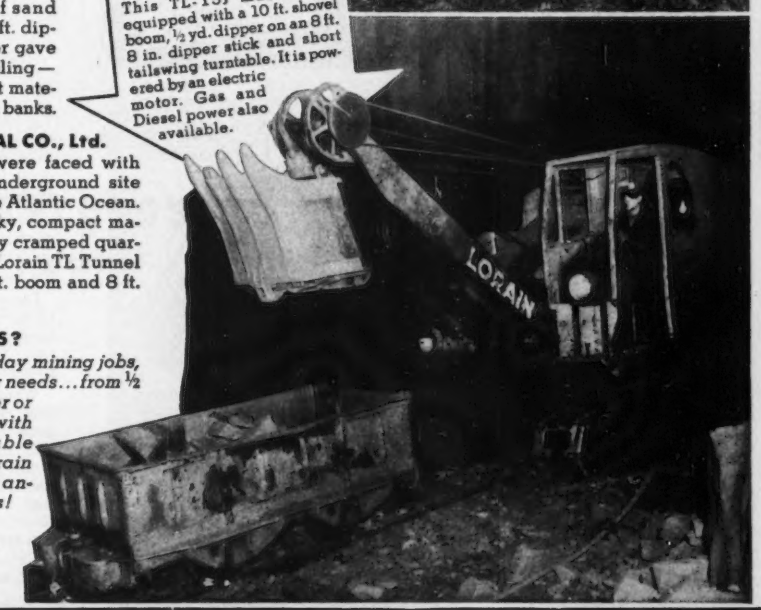
TUNNEL
This TL-15J machine is equipped with a 10 ft. shovel boom, ½ yd. dipper on an 8 ft. 8 in. dipper stick and short tailswing turntable. It is powered by an electric motor. Gas and Diesel power also available.

DOMINION STEEL & COAL CO., Ltd. of Sydney, Nova Scotia were faced with "ceiling zero" in their underground site 2 miles off shore below the Atlantic Ocean. Their need—a short, stocky, compact machine to work in extremely cramped quarters. The answer—a ½-yd. Lorain TL Tunnel Shovel with its short 10 ft. boom and 8 ft. 8 in. dipper stick.

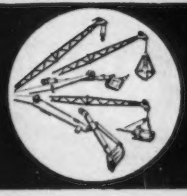
WHAT ARE YOUR NEEDS?

For the unusual—or everyday mining jobs, there's a Lorain to fit your needs... from ½ to 2 yd. classes, on crawler or rubber-tire mountings—with any of 5 interchangeable front ends. Your Thew-Lorain Distributor has the best answer to your mining needs!

THE THEW SHOVEL CO.
LORAIN, OHIO

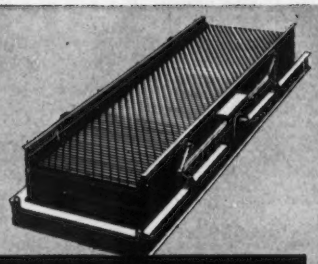


THEW LORAIN®
on CRAWLER or RUBBER



SHOVELS
CRANES
DRAGLINES
CLAMSHELLS
HOES

If your present screens don't give you these
9 SCREENING ADVANCES
You're in the market for a **SCREEN-ALL** Vibrating Screen

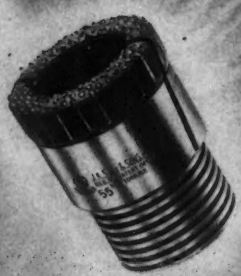


IDEAL SCREEN HAS:	LIPPMANN SCREEN-ALL GIVES IT TO YOU:
SHARPER SIZING ACTION	Perfect circle throw is possible because entire weight of body is carried by shaft. True circular motion gives maximum tumbling—every particle contacts cloth more frequently on all faces for highest efficiency.
HIGHER CAPACITIES	With a greater component of force perpendicular to deck, maximum bed stratification is achieved. No ganging up, no blinding—positive vibration equalizer transmits identical vibratory motion to all of deck.
LOWER FIRST COST	Advanced engineering of SCREEN-ALL gives unmatched simplicity of construction. All parts are made from jigs.
LONGER LIFE	With no unbalanced forces during entire operating cycle, SCREEN-ALL gives many years of efficient performance.
LESS HEAD ROOM	Because bearings are outside screen body, shaft can be mounted close enough to deck to save up to 8 inches height.
LIGHTER SUB-STRUCTURE	LIPPMANN SCREEN-ALL transmits no vibration to supporting structure. No side or end springs, no guy cables needed.
EASIER INSTALLATION	New three-point support makes setting up the SCREEN-ALL a simple task even if supporting structure is not exactly level. Body is mounted on frame precisely at factory.
REDUCED MAINTENANCE COSTS	Bearings are mounted only 7/8 in. apart. Bending moment is sharply reduced. Hub-mounted bearings are much larger than shaft-mounted bearings on comparable screens.
GREATER FLEXIBILITY	SCREEN-ALL handles wide range of materials and sizes. Slope can be varied quickly, rotation reversed, throw changed by switching hubs, quick-change decks easily substituted. 2006

LEW **LIPPMANN** ENGINEERING WORKS
4603 West Mitchell St., Milwaukee 14, Wisconsin

For all the facts, write for Bulletin 1200

HARDHED
Diamond
DRILL BITS

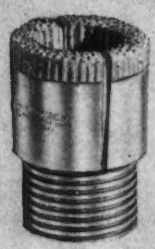


J. K. Smit manufactures the largest variety of diamond bits to give you the lowest cost per foot under all drilling conditions.

HARDHED matrix for the usual drilling conditions.
HARDHED "40" matrix for abrasive conditions.
HARDHED "55" matrix for extremely difficult drilling conditions such as badly broken, hard formations.
FERRET impregnated bits where this type gives better performance than surface set whole stone bits.

J. K. Smit engineers welcome the opportunity to discuss your drilling problems. Special equipment can be made to meet any unusual conditions.

Prompt Delivery • Prompt Resetting Service



J. K. SMIT & SONS
General Offices and Plant: Murray Hill, N. J.

J. K. SMIT & SONS of MICHIGAN
J. K. SMIT & SONS of CANADA

Here's Why it Pays You to Read the Advertising

The advertising is a rich source of valuable information. In this magazine it offers you ideas and products that may well apply advantageously to your business.

Every issue is a catalog of goods, materials, and services — quickly available to you—just for the reading.

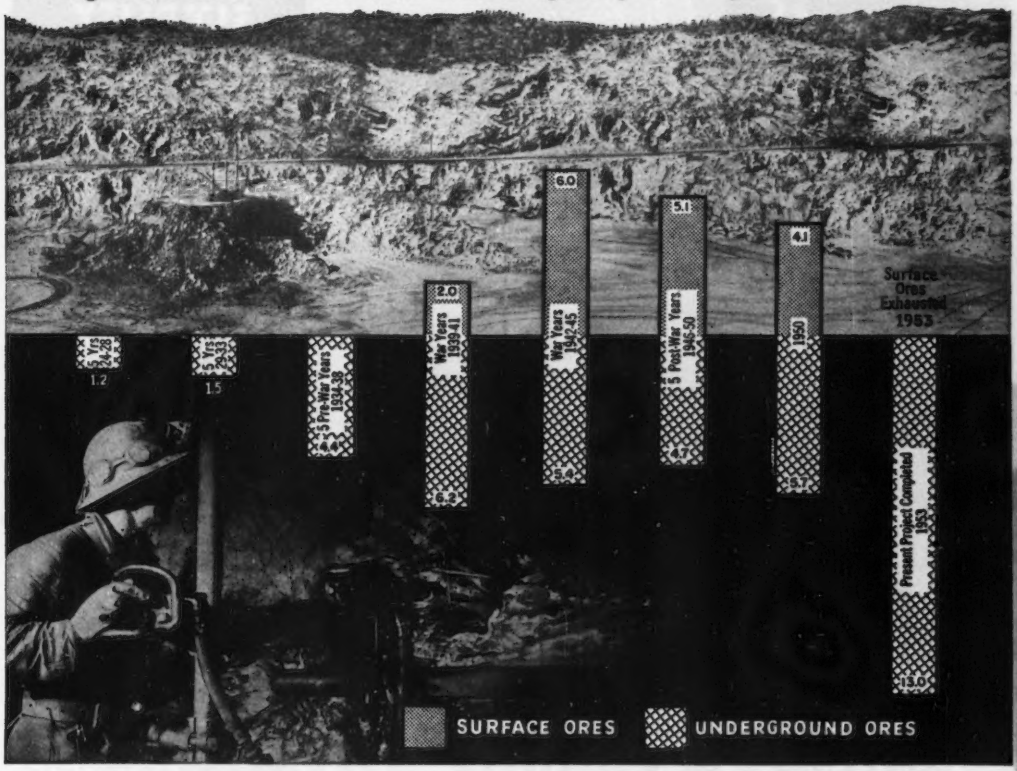
Leaders in business and industry turn to the advertising because they've discovered it helps them run their businesses more profitably.

When you read all the ads in this magazine, the chances are good that you'll get a lead that will materially help you do a better job. For example, you may find a specific piece of equipment that will be a profitable time-saver. Or a tool that will increase worker efficiency. That's why it pays to read the advertising. It's good business.

HEADQUARTERS FOR BUSINESS INFORMATION

McGRAW-HILL publications

Underground and surface ORE MINED (yearly average—millions of tons)



Underground for Defense

...started more than 10 years ago

STRENGTH...military and economic ... depends on productivity. And productivity depends on men who have devoted long years to their specialized chosen field of endeavour.

Such men with "know-how" mine nickel from the rocky rim of Ontario's Sudbury Basin ...

By increasing output with maximum speed and drawing on reserve stocks of nickel previously accumulated, they helped raise deliveries of nickel in all forms during 1950 to 256,000,000 pounds ... a record for any peace-time year.

This record, 22% greater than the 209,292,257 pounds delivered in 1949, was no accident ...

In 1937, INCO launched a vast long-range project which now makes it possible to meet the military requirements of the United States, Canada and the United Kingdom. In addition, nickel deliveries are being made to government stockpiles and the balance of the supply is being rationed among civilian consumers in all markets throughout the free world.

Since the inception of International Nickel, its fixed policy has always been to increase the supply of nickel. To meet today's needs, INCO went underground years ago.

Anticipating the eventual depletion of Frood-Stobie open pit surface ores, more than 10 years ago, INCO embarked on a program of replacing open pit with underground capacity. This required extensive enlargement of underground plants, development of new methods of mining not previously undertaken and the revamping of metallurgical processes to cope with difficulties in recovering nickel from the new types and lower grades of ores which have to be reached.

Major expansion in output of nickel from underground operations is being driven to conclusion with utmost speed. There is still much construction to be done and a number of mining and metallurgical problems remain to be solved and tested in actual operation. Barring unforeseen interruptions, full conversion to underground mining should be completed in 1953.

When the present undertaking is completed, INCO will be able to hoist 13,000,000 tons annually, and the size of its underground mining operation will surpass that of any other non-ferrous base metal mining operation in the world.

This underground expansion is being completed by INCO without interrupting current production of nickel, which is at maximum capacity.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

IN A CLASS BY ITSELF!

THE LUFKIN "MICHIGAN" CHROME-CLAD BABBITT-TYPE CHAIN TAPE

C-3100 SERIES

You'll agree the *Lufkin "Michigan"* is in a class by itself for railroad, highway, and other hard service work. Its tough steel line is protected with several heavy coats of electroplating. Both the line and deeply stamped Babbitt metal bosses are chromium plated to give it a wear-resisting, corrosion-proof all metal outer jacket. Sturdy metal reel is dull black finished. Long extra-leverage folding winding handle. Complete with two leather thongs. Graduated in feet, links, or meters. Railroad Half-Gage Mark added when specified. Order a *Lufkin "Michigan"* from your supply house now.

116

Buy LUFKIN

TAPES · RULES · PRECISION TOOLS

THE LUFKIN RULE CO., SAGINAW, MICHIGAN

132-138 Lafayette St., New York City 13 Barrie, Ont.

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AVAILABLE . . . . . .

The SEARCHLIGHT SECTION (Classified Advertising) of ENGINEERING & MINING JOURNAL is always available to you for the filling of any business need or want peculiar to the mining industry. So, whenever you offer or seek employment, used or surplus new equipment, mines, acreage, patents, etc., you can get quick action through advertising in the SEARCHLIGHT SECTION.

SIMPLIFY EQUIPMENT CONTROL WITH Ledeen CYLINDERS

Ledeen CYLINDERS

For straight line power movement. Air, oil or water operation. Medium Duty, Heavy Duty, and Super Duty models.

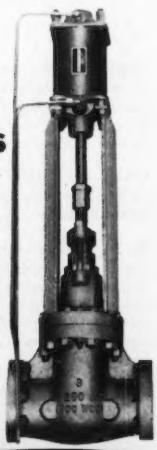
Write for Bulletin 500.

Ledeen VALVES

For actuating air or hydraulic cylinders. 14 different models for 5 different cycles, in 6 sizes. Hand, foot and power operated.

Write for Bulletin 510.

Ledeen VALVE ACTUATORS



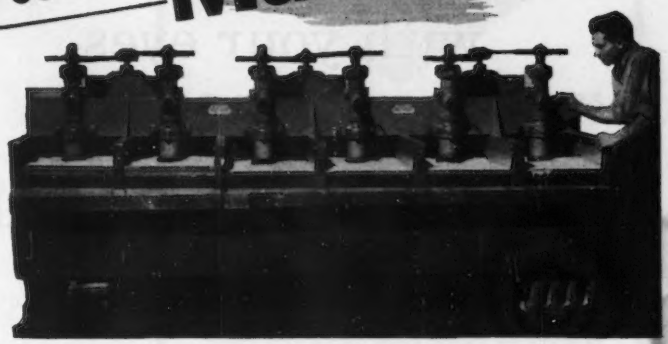
For actuating any make, size and type of valve, against any line pressure, on any fluid medium, and with any pressure available. For on-and-off or positioning service. Positive in action, economical in cost.

Write for Bulletin 512.

Ledeen Mfg. Co.
1606 San Pedro
Los Angeles 15, Cal.

TESTED AND PROVEN!

THE NEW BOOTH "Cleaner Cell" FLOTATION Machine



"On the job" tests have proved the new Booth "Cleaner Cell" type model of the Booth flotation machine to be far superior in doing a better job at lower cost. This new machine provides for accurate air control with smooth, even dissemination, and a minimum of turbulence.

NOW READY FOR DELIVERY
WRITE FOR DETAILS

• MINERALS SEPARATION • SERVICE • EQUIPMENT •

BOOTH ENGINEERS

146 SO. W. TEMPLE • Salt Lake Citv. Utah

UNIFORMLY ACCURATE SIZING

You assure uniform accuracy of sizing when you use Hendrick Perforated Plate on your vibrating and shaking screens. For highly abrasive materials the plate is heat-treated to increase its toughness and minimize wear.

The full clearance practically obviates clogging, while the ease and rapidity with which decks can be changed is another factor in keeping down screening costs.

With any desired shape and size of perforations, Hendrick Perforated Plate can be furnished—either flat or corrugated—in the proper gauges of tank, high-carbon, high-tensile, and abrasive-resisting steels, and in other commercially rolled metals. Write for a copy of Hendrick Perforated Plate Catalogue.

1876—Seventy-Fifth Anniversary—1951

SEE OUR CATALOG IN SWEET'S

HENDRICK

Manufacturing Company

70 DUNDAFF STREET, CARBONDALE, PENNA.

Sales Offices In Principal Cities

Perforated Metals
Perforated Metal Screens
Wedge-Slot Screens
Architectural Grilles
Mitco Open Steel Flooring,
Shur-Site Treads, Armorgrids

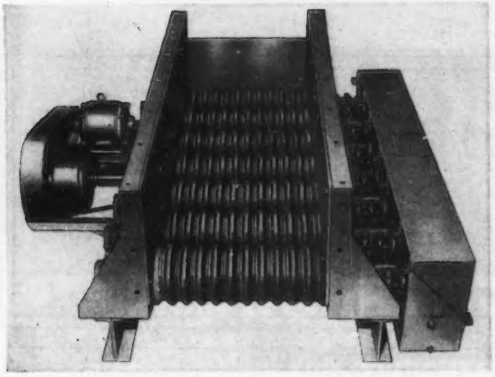
How to read with your eyes open for Business!

Read the ads! Every issue of this magazine contains ads that offer valuable services and useful products by which your business may be run more profitably.

The time it takes to read all the ads is time well spent. One ad alone can pay off—by informing you of new developments and new sources of supply, by helping you do a more efficient job. For example, you may locate one machine that will cut your production costs, or step up your output. Or you may discover that the equipment you've been waiting for is now available.

This magazine displays more ideas and merchandise than a trade exposition. Make every issue your buyers' guide. Read the ads as well as the articles. That's reading with your eyes open for business.

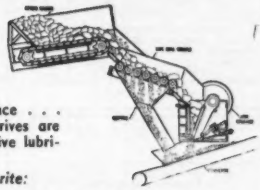
McGRAW-HILL
publications



Rugged — Efficient — Versatile

ROGERS LIVE ROLL GRIZZLY

This non-clogging, low-angle grizzly reduces surges and smooths flow of all types of material. An excellent scalping device . . . far more economical to operate than a scalping screen. Low maintenance . . . install it and forget it . . . drives are sealed in a bath of oil for positive lubrication



For detailed information, write:

ROGERS IRON WORKS COMPANY
Joplin, Missouri

PLACER GOLD

Most accurately and economically tested for . . . with the

EMPIRE DRILL

NEW YORK ENGINEERING COMPANY
75 West St., N. Y. City, U.S.A. Cable Address NYECO, N.Y.

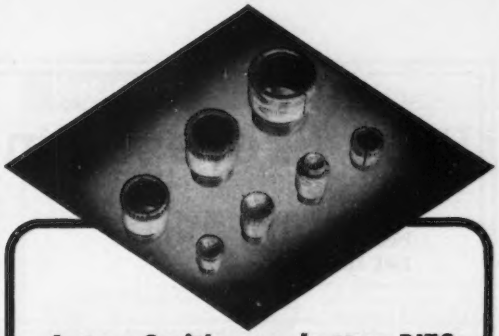
CORE DRILLING

—anywhere!

"We Look into the Earth"

- Mineral Prospecting
- Foundation Test Borings and Grouting
- Large diameter holes for Ventilation and Escapeways

PENNSYLVANIA Drilling CO.
DRILLING CONTRACTORS & MFRS.
1206 Chartiers Ave. PITTSBURGH, PA. WAlnut 1-5816



Anton Smit's are better BITS

The DIAMOND BITS of Anton Smit & Co., Inc. are the best bits because:

1. They have been steadily improved over a 20 year period...
2. Using a Tag-And-Report system whereby the history in use of Anton Smit Diamond Bits is traced, known and employed in further perfecting them...
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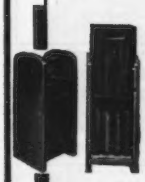

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No. 20	3.90 ea.	No. 72	8.70 ea.

DETONATOR BOX PRICES ARE AS FOLLOWS:
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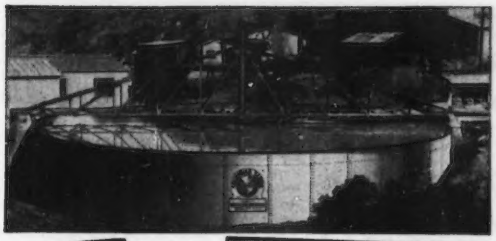

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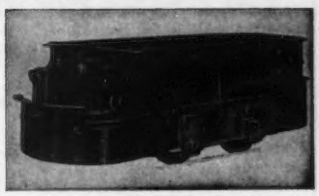

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SHOVEL LOADER FOR LARGE DRIFTS, 3 TONS PER MINUTE
Guaranteed 95% New

COST $4880.00
OUR PRICE 3500.00

F.o.b. Chicago

CENTRAL CONTRACTORS SERVICE, INC.
GEORGE A. CARLSON, Pres.
1150 N. North Branch St., Chicago 22, Ill.

FOR SALE
AT A SACRIFICE PRICE
DENVER DOUBLE DRUM

MINE HOIST

7500 LB. 500 FT. PER MINUTE
72" DRUMS 48" FACE 3000 FT. CABLE

150 H.P. G. E. MOTOR

CONTROLS, SWITCHES, ETC.

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J. J. SUGARMAN CO.

ESTABLISHED 1906
629 S. HILL ST., LOS ANGELES 14, CALIF.
TEL. TUCKER 3131

Rotary Kilns—8½ x 60'—8½ & 9½ x 200'
Rotary Dryers—3' x 30'—4' x 30'—6' x 40'—8½' x 50'—8½' x 60'—8½' x 70' & 7½' x 70'.
Tube & Ball Mills—5' x 9'—5' x 22'—5½' x 18'.
Fuller-Lehigh Mills—22"—47" & 52"—Bradley Mills.
Jaw Crushers—From 10" x 6" up to 36" x 24".
Crushing Rolls—From 10" x 12" up to 72" x 20".
1—Complete Linel Hydrating Plant.
Sturtevant Rotary Ring crushers—No. 6—No. 1—No. 1½ and No. 2.
Ring Roll Mills—Sturtevant No. 1—No. 2 duplex.
15'—18' & 19' Herreshoff furnaces.
Gyratory Crushers, No. 3 and No. 12.
5' & 9' Gayto — 6' & 8' Raymond Whizzer Air separators.
Magnetic separators—Jigs—screens—classifiers and thickeners.
5', 6" & 7' dia. Rod Mills. Mine Hoists.
8' x 10'—8' x 12'—11½' x 19' Rotary Filters.
One 8 roll Raymond Mill low side. 8 roll high side.
One 5 roll Raymond Kiln Mill.

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FLOTATION MACHINES
2—#24, 8-cell Denver "Sub-A"—43" x 43" cells—wood tanks, complete with motors and new rubber impellers.

CONCENTRATING TABLES
2—#6 Wilfleys, with rubber deck covering
3—6' x 16' Wemco Deister Type

HOISTS
1—#21½ Vulcan Sgl. Drum, with U-6 Gas Power Unit, condition like new
1—15 HP Box I. Wks. Sgl. Drum with 15 HP Slip-ring Motor
1—#6½ Vulcan Hoist
1—7½ HP Hoist with Motor

FILTERS—DISC
1—4', 6-disc, Eimco, with Vac. Equip. New Sectors and Bags

CONVEYORS AND CRUSHERS
1—20" Conveyor, complete with Troughers & Motor, for 40' centers—without belt
1—30" Conveyor, complete with Troughers & Motor on steel frame for 70' centers —without belt
1—7 x 10 McClair Jaw Crusher
1—9 x 40 Austin-Western Jaw Crusher
1—10 x 20 A.C. Blake Crusher

MISCELLANEOUS
1—Bucket Elev. 25' centers, 5½" x 6" Buckets. Direct geared to 3 HP Motor
1—12" x 18" Duplex Hartz Jig with Motor
1—D-4400 Cat. Diesel V-belted to 30 KVA 220 volt AC Generator
8—2" Wilfley Sand Pumps
1—6000# Chassis Ironton Bat. Loco. 36" ga.
1—60" x 23' Denver Cross-flow Simplex Spiral Classifier
3—37½ KVA Transformers 460-230/115 volts
1—12" x 30" Suspension Type Jeffrey Vib. Feeder
25 Tons 85# Relayers
10 Tons 65# Relayers
1—Metal Mine Phone
Motors—¼ HP to 50 HP
Drifters—Stopers—Jackhammers
Structural Steel

SEND FOR BULLETIN NO. 10

FLORENCE MACHINERY & SUPPLY CO.

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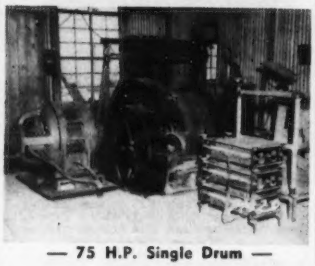

— 75 H.P. Single Drum —

THREE SHAFT HOISTS

1—50 H.P. Single Drum Stearns-Roger. 5000# rope pull, 340 f.p.m., complete. Drum 36" dia. 28" face, 7" flange, motor, controls, grids, depth indicator.

1—75 H.P. Single Drum, Denver Engineering Co. 5000# pull, 400 f.p.m. Drum 23½" face, 42" dia., 6" flange. G.E. Motor, controls, grids (see picture above).

1—100 H.P. Double Drum, Allis-Chalmers 6500# pull, 520 f.p.m. drums 48" dia. 30" face, 7" flange, band type brakes, complete with 112 or 125 H.P., 2300 or 440 volts, motor, controls, grids. (Excellent condition.)

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308 Newhouse Bldg. Salt Lake City, Utah
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Priced for Immediate Sale!
1—6x6 ALLIS-CHALMERS
1—6x5 ALLIS-CHALMERS
HERRINGBONE GEARED TO DIRECT MOTOR DRIVES
100 H.P. MOTORS

2—5x6 ALLIS-CHALMERS
GRID DISCHARGE HERRINGBONE GEARED TO DIRECT MOTOR DRIVES 75 H.P. MOTORS

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ESTABLISHED 1906
629 S. HILL ST., LOS ANGELES 14, CALIF.
TEL. TUCKER 3131

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Mill: 5 ft. diam. x 4 ft. long
Thickener: 10x8 Wemco 440-volts
Flotation: 2-cells 24x24 Sub-A
Flotation: 4 Fags 44x44; 440 v
Portable crushing plant: Pioneer 9x18 crusher, 24x14 rolls, conveyor, elevator, screen, power units, etc.
Drill sharpener: GDCo #6 w/punch etc.
Bit grinder: MASSCo TVM-38; 440-v
Loader: Eimco Model 12-B
Hoist: 100 hp double-drum 440-v
Slusher: 3-drum Sullivan C312. 50 hp 220/-440-v; 66" blade scraper.

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DRYER or KILN: Allis Chalmers 10 ft. x 90 ft., heavy duty, plate thickness 22.95 lbs. per sq. ft., complete and with or without Coal fired Furnace, Western Precipitation Dust Collector, Clarage #41 Exhauster, Motors, Control equipment, etc.
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Syntron F55 Vibratory Pan Feeder, 36" x 78" flat pan trough. NEW, UNUSED. Both above with control equipment.
Manganese Apron Feeder 44" x 16 ft. complete. NEW condition.
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COMPRESSOR: Worthington 2 stage, 29/-18-½ x 21, 600 H.P. synchronous motor, 3 phase, 60 cycle, 440 volt, 180 RPM, 100 lbs. pressure, complete with auxiliary equipment. In operation now, available immediately.
DIESEL MOTOR: 122 H.P. Caterpillar D13000 complete with clutch, V-belt pulley and spare parts.
BIT DRESSER: Bucyrus Erie model 12 for bits 6" to 12". This is a complete forge shop with furnaces, jib crane, 500 lb. air hoists, all auxiliary equipment and portable steel building 36 x 36 with cupola.
CRAWLER CRANE: Electric 1-¾ yd. capacity, 60 ft. boom, old model, excellent condition. A real bargain.
MINE HOISTS: Single and double drum 150 H.P. to 2500 H.P.
BRIQUETTING PRESS: Capacity 18 tons per hour, 33" dia. rolls.

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SPECIAL — Allis Chalmers Type N Gyratory crusher or Worthington Gyratory—Ready to go complete with Drive $2,500

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Joplin Machinery & Electric Company
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BRAND NEW "GOODRICH"
4-inch Discharge Hose

Ideal for Ranch or Farm Brand new "Goodrich" Discharge or Fire Hose: 200-lb. pressure, rubberlined, heavy jacketed, in 50-ft. lengths, complete with male and female bronze couplings.

USES Portable Pipe Lines, Discharge on Pumps, Irrigation, Sewer & Trench Work, Sprinkler Irrigation, etc.

SALE PRICE **60¢** PER FOOT

50-ft length complete with male and female bronze fittings $30.00

Mail Orders Filled. Colorado Residents Add 2% Sales Tax

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BERNSTEIN BROTHERS
SINCE 1890 — PHONE 8404
PUEBLO, COLORADO

MOTORS—M. G. SETS—TRANSFORMERS

SQUIRREL CAGE MOTORS
3-Phase, 60-Cycle

Qu.	HP	Make	Type	Volts	R.P.M.
1	600	G.E.	IK	2200	514
1	600	G.E.	KT-412	2200	435
2	300	Whse.	CS-890	2300	1780
1	250	Whse.	CS	2200	1160
1	200	Whse.	CS-873C	2200	1160
1	200	Al-Ch.	AR	440/220	580
2	125	Al-Ch.	AR	2200	1750
1	125	Whse.	CS-761C	440/220	1750
1	125	C.W.	126-Q	440/220	430
2	100	Whse.	CS-663C	440/220	1750
1	100	G.E.	IK	440/220	1800
1	100	Al-Ch.	AR	2200	1160
1	100	Al-Ch.	AR	550	690
1	100	F.M.	H241B	440/220	435
1	100	Whse.	CS-918	2200	495
1	75	G.E.	I-K15	440/220	570
1	75	Al-Ch.	AR	2200	1765
1	75	Al-Ch.	AR	2200	1750
1	75	Al-Ch.	AR	2200	690
1	50	G.E.	KT	440/220	1160

SYNCHRONOUS MOTORS
3-Phase, 60-Cycle

Qu.	H.P.	Make	P.F.	Volts	R.P.M.
1	3000	Whse.	80	4800/2400	720
1	700	G.E.	80	2300	720
1	600	Whse.	80	2400	720
1	400	Whse.	90	440	600
1	300	Whse.	80	440	514
1	268	Al-Ch.	100	2200	900
1	150	G.E.	100	2200	900
1	150	G.E.	100	550/2200	600
1	150	G.E.	80	550/2200	450
3	125	El. Mchy.	100	4800/2400	900
1	125	G.E.	80	2200	900
2	100	Whse.	80	440/220	1800
1	100	Whse.	100	2200	1200
1	100	Ideal	80	220/440	900
2	100	G.E.	80	220/440	600
1	60	G.E.	80	220/440	1200
2	50	G.E.	80	2200	600

SLIP RING MOTORS—CONSTANT DUTY
3-Phase, 60-Cycle

Qu.	HP	Make	Type	Volts	R.P.M.
1**	3000	G.E.	MT	2200	356
1**	1200	C.W.	SR	2200	257
2**	1000	Al-Ch.	ANY	2200	235
1**	600	G.E.	MT-20	2200	360
1	500	Whse.	C.W.	4600/2300	514
1	500	Al-Ch.	ANY	4000/2300	514
1**	400	G.E.	IM	2300	590
1**	400	Al-Ch.	ANY	2200	514
2	500	G.E.	I-16-M	2300	450
2	400	G.E.	MT-412	2200	450
1	300	G.E.	I-15-M	2200	1200
1	300	Al-Ch.	ANY	2200	514
1	250	G.E.	MT-414	2200	300
1	200	G.E.	I-16-M	2200	585
1	150	G.E.	I-15-M	2200	1750
1***	125	Whse.	CW-870	2200	870
1	100	F.M.	H20C	440/220	900
1	75	G.E.	IM	440/220	695
1	75	Whse.	CW-7540	440/220	690
1	60	Whse.	CW	440/220	900
1	50	G.E.	MT-536	2200	1150
2	50	Al-Ch.	ARY	440/220	900
1	50	F.M.	SR	440/220	600
1	50	Al-Ch.	ANY	2200/440	435

** Mill type pedestal bearing.
*** 3-Bearing.

MOTOR GENERATOR SETS

Qu.	K.W.	Make	R.P.M.	Volts D.C.	Volts A.C.
2	1000	G.E.	514	575	4000/2300
1	500(34)	Whse.	1200	120/240	2300/440
2	500	C.W.	720	575	4000/2300
1	500	C.W.	720	250/275	4000/2300
1	500	C.W.	720	250/275	2300/440
1	350	G.E.	720	250	2300/440
1	200	Ridgeway	900	250	2300
1	155	G.E.	720	250	2300/440
1	150	Al-Ch.	1200	250	2300/440
1	150	G.E.	1200	300	2300/440
1	100	Ridgway	1200	275	4000/2300
1	85	C.W.	1200	250	2300/440
1	75	Sciu	1200	230	440/220
1	75	Al-Ch.	900	250	2300
1	50	Burke	1800	240	440/220
1	30	Reliance	1800	250	440/220
1	25	Whse.	1200	120/240	440/220
1	20	Reliance	1800	250	440/220

(34 — 3-UNIT SET)

DIRECT CURRENT MOTORS

Qu.	HP	Make	Type	R.P.M.
4***	800	Whse.	Encl.(Rev.)	600
1	350	G.E.	CD-169	1150
1	325	Whse.	QM-660. 6	450/900
1	250/250	El. Dy.	No. 22	400/1200
1***	200	G.E.	MPC	500/1200
1	200	Whse.	Mill	300/1200
1	300	Whse.		240/300
1	180	G.E.	MPC	400
2*	150	C.W.	83-H	890
1***	125	Whse.	SK-190	600
1	100/125	Rel.	1995-F	300/1200
2	100	Rel.	1050-T	400/1200
1	90/160	G.E.	MPC	625/1125
1*	50/75	Rel.	1995-P	300/1200
1	35	G.E.	RF-14	300/1500
1	35	G.E.	CD-125	400/1200
1	35	G.E.	CD-147	300/1200
1	35	Rel.	35P	250/1000
1	32½	Whse.	SK-150	400/1200
1*	30/75	Whse.	SK-151L	400/1200
1	30	Al-Ch.	E-145	400/1200
1	30	G.E.	CDM-105	875/1750
2	27½	El. Dy.	15B	450/1350
1	25	G.E.	RF-13	400/1600
1	25	G.E.	CD-123	400/1200
1	25	Whse.	SK-140	400/1200
1	25	Whse.	SK-111L	250/1000
2	20	Al-Ch.	E-130	400/1200
3	20	G.E.	CD-123	400/1200

All above 230-VDC except where marked ***.
***—Pedestal bearing mill design $25/600-VDC.
Rev.—designed for mill reversing service.
*—T.E.F.C.

TRANSFORMERS (POWER)

Qu.	K.V.A.	Make	Type	Phase	Voltage
1	7500	G.E.	H	3	33000/29700–13800/22600
1	6500	G.E.	HT	3	27000/24300–2300
3	1500(New)	Gregory	(X)	3	4160-480
2	750(New)	Gregory	(X)	3	4160-480
3	250	Packard	OISC	1	13200-2200
3	130	G.E.	H	1	19000/9500–550/2200

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6 x 24
WORTHINGTON
HORIZONTAL TRIPLEX PUMP
730 gal. per min. @ 750 lbs. press., Wt. 73,500 lbs.
300 H.P. G.E. MOTOR
TYPE I-17B w/STARTER & SWITCHES
580 R.P.M. WT. 7800 lbs.
SACRIFICE PRICE!
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ESTABLISHED 1906
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Otago, New Zealand
Designed and Manufactured in England, capacity with minor modifications 150,000 cu. yds. monthly, digging depth 60 feet at 45. Particulars from:
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- Ball Mills
- Slushers & Tuggers
- Pumping Eqpt.

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ELECTRICAL CABLE
- for every industrial and power application.
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- Large stocks on hand of high voltage, lead covered cables not ordinarily stocked by your regular supplies.
- Cut to length. Reasonably priced.

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Immediate Shipment

1—24″ Gauge Battery Locomotive with two 40-cell batteries including all charging equipment.

1—50,000 gallon tower tank, 150 ft. high, all steel spherical bottom, cone roof or top.

2—Reels of new 1⅛″ Hazard Brand hoisting cable 6x19 plow steel, hemp center Seal construction, 6,850 ft. in each reel.
We also have a like amount in good used cable.

1—500 H.P. double drum mine hoist. All complete details on request.

1—6′x24 Dorr DSFX Heavy Duty Classifier

1—New 36″x10′ Heavy Duty Feeder with steel hopper.

1—Eimco 4′ dia. 6′ face drum filter, complete with all filtrate and vacuum equipment.

1—New Telsmith 48″ Gyrasphere Type S Secondary Crusher with grooved pulley.

1—New Telsmith 36″ Gyrasphere Type S Secondary Crusher with grooved pulley.

1—20′ dia. x 10′ deep Dorr Thickener, complete with redwood tank, overflow launder, low beam superstructure. Late model.

1—Ingersoll Rand Air Compressor, size 22 x 16 and 13 x 16 Duplex Imperial Type 10, complete with endless belt. Short belt idler and 160 HP motor with compensator, necessary piping and large air receiver. Capacity 960 cu. ft. actual at 170 RPM.

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Phone Sutter 1-7224

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ELECTRIC EQUIPMENT CO.
ROCHESTER 1, N. Y.

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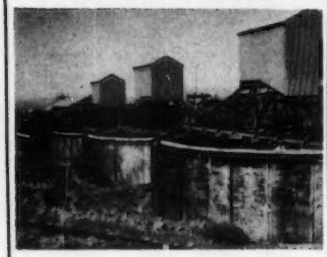

4—Eimco Thickeners—
40′ x 10′ 50′ x 10′
VERY GOOD CONDITION

3—40′ x 10′ and one 50′ x 10′ Thickeners, steel tanks, truss type superstructures, heavy duty rakes, 3 H.P. Gearmotors, 220/440 volt.

OTHER THICKENERS IN STOCK

2—20′ x 10′ Denver low head, bolted steel tanks
2—40′ x 10′ Denver low head, welded steel tanks
1—45′ x 12′ Dorr low head, welded tank

—All with gearmotors 220/440 volt—

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⅞ to 1¼ diameter—20-24 ft. lengths
Top Quality Phoenix Brand
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Price $225 per ton (Solid Bore)
$285 " " (Hollow Bore)

Minimum Order 2 tons

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FS1193 Engineering & Mining Journal
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1—24" Gyrasphere Crusher Shop No. 6173 $4,500.00

1—ICS Telsmith Gyratory Crusher Shop #410 ..... $2,100.00

1—13B Telsmith Gyratory Crusher Shop #1459 ..... $4,000.00

2—Single drum Clyde friction electric hoists with 7-½ HP motors, 220 V. 60 cy. 3 phase, rope speed 35 ft. per min., pull 5,500 lbs. .....$350.00 each

1—52B Bucyrus Erie combination machine with 70 ft. boom, 31 ft. shovel front, 18 ft. dipper stick, powered by 6 cylinder Atlas Diesel Engine 8x9½, 450 RPM, located at our Linthicum Plant. This machine can be inspected in running order after two days notice $20,000.00

1—200 H.P. Chicago Pneumatic Diesel Engine Type RHA-40 327 RPM, 5 cylinder, 10-¾" x 13-¾" with auxiliary compressor for starting and lubricating oil cooler. This machine is stored at our Leonardtown Plant, Leonardtown Md., and was overhauled completely before storing $3,000.00

1—Fairbanks Morse & Co. Diesel Engine—Model 36A5⅛S—6 cylinder—HP Cont. 90—RPM 1100—Maximum HP 140—Serial No. 794682—which is equipped with Twin Disc Clutch Co. single disc clutch—Model B 214 PI—Spec. No. 10220—This engine has not been used since having a complete overhaul by the Fairbanks Morse & Co... $1,600.00

Necessary equipment for a D.C. lifting magnet as follows:
1—Complete R. H. Sheppard Co. Hanover, Pa. 4 cycle Diesel Engine Model #13—Continuous Full Load Rating 16 HP—1200 RPM—Engine No. 4307 with radiator and 1 D.C. Generator, Fidelity Electrius Co., Inc., Lancaster, Pa. 10 K.W., 240 Volts Frame 603, Amps. 41, RPM 1200, Type LCD, Phase D.C. No. 043036 to make a single unit. Also 1 Set (4) storage batteries—1 Cutler Hammer Motor Controller #549 H 17A (Master Switch)—1 Fuse Box with Fuses—1 Cutler Hammer Lifting Magnet Controller No. 549 H 24 A, 230 Volts—1 Swan Electric Co. Hanover, Pa. Voltage Controller No. 952 .. $1,800.00

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Mining Machinery, Equipment, T. Rail, Hoists, Headframe, Ore Bin, Pumps, Compressor, Diamond Drill, Rods, Ball Mill, Flotation Cells, Assay Supplies, Cable, Stopers, Drills, Etc.

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Gas Electric — 35 ton — Double Truck; Standard Gauge; 6 Cyl. BUDA GAS ENGINE; 4 Elec. Driving Motors—One on Each Axle; DC Generators; Comb. Straight & Auto. Braking Equip't.
WILL PULL 15 to 20 LOADED FREIGHT CARS ON LEVEL
Immediate delivery — Photograph available
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Pneumatic tired Williams double-drum mine hoist, starter & lights, cat-head, slusher scraper, 15′ "A" frame for sinking, two snatch blocks. $1000.00 cash.
FS 9758 ENGINEERING & MINING JOURNAL
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1—4x4 Colorado Iron Works Ball Mill with new hard iron liners.

1—36"x14′8" Rake Type Classifier—reconditioned.

1—Reconditioned mine hoist with drum capacity 500 ft. ½" cable, clutch, brake, indicator.

Cast Iron Conveyor Pulleys
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1 MODEL 12-B-55 EIMCO ROCKERSHOVEL. USED 60 SHIFTS A-1 CONDITION—TAKES TOO MUCH HEADROOM IN OUR SMALL COAL SEAM.
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